POWER

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Men and Machines

HE WROTE his check for the high-priced car and, having learned to start, stop and back up without hitting the curb, invited the family to ride out to a Sunday dinner.

The next morning he announced that the bus was a bargain sale. Miles from home or help it had stalled. After an hour of grilling a service man appeared.

"And all that he did," explained the crestfallen autoist, "was to tighten up one screw and she went off as well as ever."

"If that's all the matter with it what do you want to sell it for?"

"Matter? Why man, there's a million screws on that thing and I am a lawyer."

The ordinary city dweller knows as little about the mechanism of the twentieth century civilization as he does of that which drives his automobile.

Of the principles and processes involved in the conversion of the raw materials of nature to the convenient and artistic forms in which they are available for his use and enjoyment he knows little. He rarely has occasion to think of them or opportunity to learn.

Of the steps by which in a few years the change from individual to mass production of the essentials of life has come about and the tools and methods by which it is intensively carried on, he is but vaguely conscious.

The wayside shops of the blacksmith, currier, shoemaker, machinist and carpenter no more attract curious boyhood and exude popular information as to how things come to be.

An attempt is being made in New York City to furnish to those interested a chance to know more of the scientific and industrial progress of the last century and a half by exhibiting and demonstrating the tools, products and processes of industry as they are exhibited at the great museums at Kensington and Munich.

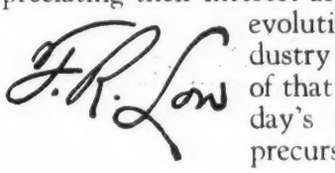
The Museums of the Peaceful Arts, founded by the late Henry W. Towne and Jacob L. Schiff, opened on the twelfth of this month at its new quarters an exhibit entitled Men and Machines.

The industrial history of the United States from colonial times will be exemplified through models, working and still, machines and processes, motion pictures, photographs, graphical and statistical material.

Frederic B. Pratt, head of Pratt Institute, is president; Prof. Charles R. Richards, who has made an extensive study of industrial museums, vice president; and Dr. Calvin W. Rice, secretary of the American Society of Mechanical Engineers, secretary.

The present exhibition is to last a couple of months and will probably be followed by other demonstrations while the collection and preparation of permanent exhibits to cover the 30,000 square feet of floor space now available goes on.

May the hopes of its founders be realized and the efforts of its promoters be crowned with success. We have been so busy making industrial history that we could not stop to keep its records. We have merrily scrapped apparatus and operations without appreciating their interest as steps in the evolution of the industry of today and of that of which today's will be the precursor.



EDITORIALS

Wave and Tide Power Developments

POWER from ocean waves and tidal flow has long been the inventor's will-o-the-wisp. Almost legion are the contrivances that have been tried or proposed for utilizing the power of the waves. Many employ floats that rise and fall with the tide, their reciprocating motion being used directly to pump water, or being converted into rotary motion by some mechanism. Another arrangement is to translate the wave motion into a hydraulic-ram effect for pumping water into an elevated reservoir to operate a waterwheel. Still another is to connect a closed vertical chamber by a tunnel to the ocean and use the rise and fall of the water in the chamber, to compress air, which is converted into power. None of these plans has been commercially successful.

Wave power should not be confused with tidal power. The latter is based on the idea of filling a reservoir at high tide that at low tide is employed to drive waterwheels. This part of the plan involves no new principle, and has been used on a small scale to drive manufacturing plants. Although heads are available from the tide, several times as great as some used in economical hydroelectric developments, they vary from a maximum to zero. To provide a continuous power supply from an intermittent source and do it economically has been the big problem in all tide-power projects of any consequence. Where it can be done, the use of two reservoirs has been proposed. One of these is a storage reservoir into which water flows at high tide, the other, a discharge reservoir that empties at low tide. By putting the plant between the two reservoirs it can be operated continuously even though the head varies.

A combination hydro and thermal plant for the development of power from the tide is described in this number. With this arrangement the excess power generated through the medium of a friction brake, when the hydraulic head is a maximum, is stored as hot water in an accumulator under high pressure. When the hydro plant develops insufficient power, the energy stored in the hot water is used in the form of steam in a steam turbine to supply the deficiency. Practically all the equipment used is standard, the novel feature being the way it is applied. A three-hundred horsepower experimental plant has been built and plans are being worked out for larger developments. Even though the experimental plant has worked successfully, the question still remains, can a project of this kind compete with other power sources? There is little doubt but that tidal power will be used extensively in the future, but the low cost of power from other sources, makes its present economic status doubtful, except under very favorable circumstances.

Helping Business

THE EXTENT to which the materials requirements of the various new gas pipe lines have kept factories busy is evidenced by the activity in steel-plate mills, pipe fabrication shops and gas-engine factories, some of which would be operating an exceedingly short time if the gas-line purchases had not been made.

Part of the drop in the demand for steel-plate by the automotive industries has been offset by the steel requirements of the pipe lines. Pipe fabricating and welding factories have been working overtime to fill orders for the thousands of miles of high-pressure piping. The companies building gas engines of suitable size, have found their factories swamped with engine orders. One firm at present has more than forty gas-engine compressor units of over one thousand horsepower capacity now going through the shops. Another is equally busy and for the year these engine orders have totaled over one hundred thousand horsepower. Accessory manufacturers have had their share. One factory is filling an order for almost two hundred eight-inch metallic piston-rod packings. The manufacture of other accessories, such as ignitors and piston rings, have also been able to tide over an otherwise dull season.

Barton Station Compared With American Plants

OPERATING and test results obtained at the Barton power station (Great Britain) were presented some months ago before the Institution of Mechanical Engineers in a paper by H. L. Guy and H. C. Lamb. This report, supplemented by the comments of K. Baumann, and later reprinted by the Metropolitan Vickers Electrical Co., Manchester, England, contains detailed information of interest to British and American engineers.

The report is valuable, first, because it analyzes in some detail the excellent performance of the Barton Station, and second, because it makes significant comparisons with American plants.

The Barton Station, started in 1920, was recently extended by the addition of a 41,000-kw. turbine-generator with four-stage bleeder heating. This unit takes steam from the original boiler room at a pressure of 360 lb. and a temperature of 700 deg. In the report station performance has been analyzed in such a way that the new unit with its proportional part of the boiler room is considered as a separate plant, called "Barton B."

Comparisons are made with Columbia, Richmond and other American plants having good records. Net heat consumption per kilowatt-hour (based on station send-out plus transformer losses) ran 12,462 for Columbia, 13,700 for Richmond and 14,500 for Philo. The corresponding figure for Barton B was 14,545 B.t.u.

The authors point out that Barton B is penalized in this comparison by a very poor coal running 11,100 B.t.u. as fired and 15.5 per cent ash. On the other hand, the Barton B installation was made in 1928 and the test period was in 1929. The American performances compared were dated two or three years earlier.

Powerton Station (*Power*, June 10, 1930) average 12,455 B.t.u. for four months last winter. This figure is based on actual station send-out and on an Illinois coal running 10,045 B.t.u. as received, 15 per cent ash and three to four per cent sulphur. Thus Barton's handicap of poor coal is equalized. On the other hand, Powerton's steam conditions (600 lb. and 725 deg.) give it a distinct advantage.

To eliminate variations due to coal and steam conditions the British authors have reduced turbine-room efficiencies for the various plants to the basis of 350-lb. pressure, 700 deg. and 29-in. vacuum. On this basis the figure of 30.24 per cent obtained for Barton B slightly exceeds that of the American plants listed.

This is of interest and indicates good turbine design and construction. While American engineers attach more importance to over-all plant performance, it admittedly introduces a fuel-quality factor that is beyond the control of the designer. Hence figures showing comparative turbine room performance have a definite value.

However, in making such comparisons, most American engineers will prefer to stress actual thermal efficiency rather than efficiency reduced to the basis of common steam conditions. Higher pressures and temperatures are open to all. Actual increases in thermal efficiency are equally creditable to the designer whether they are obtained by raising steam conditions or by use of refinements in turbine construction and heating cycles. In this connection it is worth noting that Columbia shows a net turbine-room heat consumption of 10,576 B.t.u. per kilowatt hour, and Barton B 11,187 B.t.u.

Industrial Wastes and Power Plants

MUCH has been written about the economies of working up industrial wastes into commercial products. Little has been said, however, about the expense to which others may be put by the reckless disposal of industrial wastes. Many power plants suffer from such disposal, yet little or no concerted effort has been made by power plant owners to have the evils corrected.

In one case an up-stream laundry discharged its waste water into a river from which a power plant took its cooling water. Soap suds, threads and lint tended to plug up condenser tubes and necessitated frequent and expensive cleaning.

Another plant was troubled by the presence up-stream of stock yards and a glue factory. The wastes from these were discharged into the river and contaminated the cooling water. Not only did the condenser tubes become plugged, but rapid growth of algae resulted in hot weather. The loss in vacuum due to these causes led to a substantial increase in the coal bill.

In still another case the wastes from an up-stream chemical plant so polluted the water that an expensive water-treating plant had to be installed to make it fit for use in industrial boilers. Furthermore, corrosion in condenser parts was accelerated.

These losses are becoming so significant that it would appear to be a profitable move, for power plant owners to unite in efforts to bring about some limitation to this costly nuisance.

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7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

TIDAL POWER PLANT Combines HYDRO AND STEAM

A 300-hp. tide power plant is in operation in England. Excess power produced during low tide, when the head is high on the waterwheel, is stored as steam and used in a steam-turbine generator to supply power at high tide, when the hydro plant cannot operate

By PAUL SHISHKOFF
London, England

STORAGE of power in large quantities other than by impounding water, which is often not practicable, is a problem that has not been solved commercially. The usual method proposed for storing power on a large scale, especially in connection with tidal power systems involves using the surplus power to pump water to a high-level reservoir. This water is used to help supply the power demand when the main development is insufficient. The obvious disadvantage of this method is the great expense incurred in providing the high-level pumps, pipes, storage reservoirs and high-head hydro-electric generating plant.

The author has evolved a system for developing tidal power, Fig. 1, in which each hydro-electric generating unit consists of a standard waterwheel coupled to an electric generator. There is a water brake on the turbine shaft similar to the type used extensively for testing large engines. The brake is connected to a thermal-storage vessel and the water is circulated between them. When the water power available exceeds the electric power demand, the surplus is absorbed by the brake and stored in the water in the form of heat. The brake is arranged to operate as the turbine governor in such a manner that as the load on the generator decreases or the head on the turbine increases, the quantity of water admitted to the brake is increased. This increases the braking load and controls the speed of the water turbine automatically.

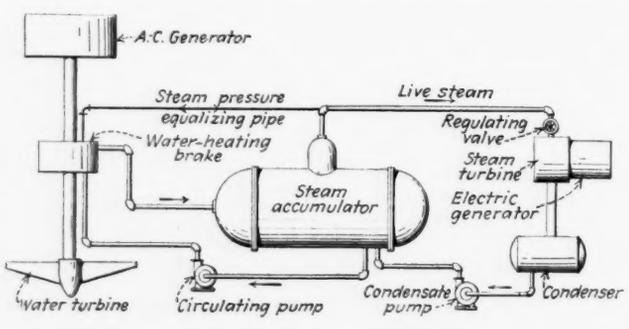


FIG. 1—SIMPLIFIED DIAGRAM OF THE TIDAL POWER PLANT

When the power of the waterwheel exceeds the load of the generator the excess is used to heat water in the brake and is stored in the accumulator. At times when the waterwheel cannot supply the load, the deficiency is made up by the steam-turbine driven generator operating on steam from the accumulator.

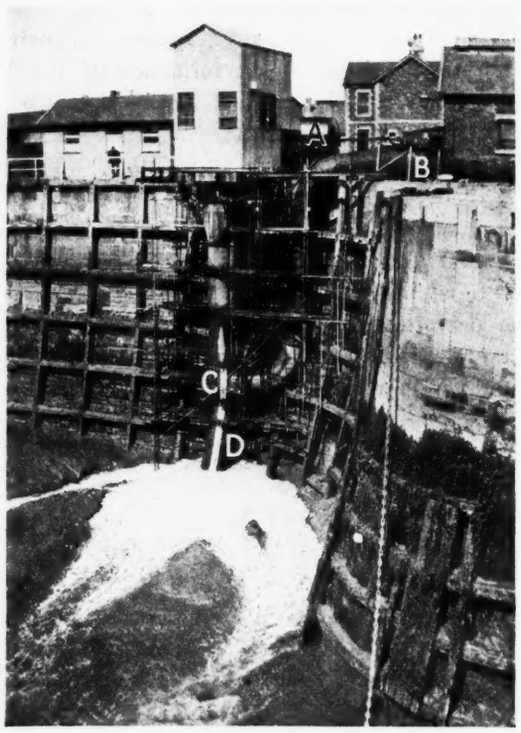


FIG. 2—THE 300-HP. TIDAL POWER PLANT AS INSTALLED AT AVONMOUTH DOCKS

At *A* can be seen one end of the steam accumulator. The pipe *B* leads from the docks down to the waterwheel *C*, which discharges through the draft tube *D*. The waterwheel shaft extends up into the tall building in front of the accumulator, and connects to a water brake and an electric generator. The steam turbine-generator is also in this building.

A feature of this system is that it is proposed to regulate the flow of water to the brake so that the surplus energy absorbed by it will be sufficient to raise the water to a temperature of 390 deg. F., corresponding to 200 lb. gage pressure of steam. The water in the brake, owing to the pressure regulation system, remains fluid, and is withdrawn from the brake at high temperature and stored as hot water in the accumulator.

When the electric power demand exceeds that which

can be directly supplied from the available water power. due, in the case of tidal power, to the change in water level, the reserve energy stored in the steam accumulator is utilized in a steam turbine. By reducing the pressure in the accumulator a part of the water is converted into steam. The heat necessary to produce vaporization is given out by the remaining water, which is slightly reduced in temperature. This is the principle of the falling-pressure accumulator, of which a large number have been in operation for years. The steam is used for driving an ordinary standard steam turbine-generator set designed to work under varying pressure.

The only element in the proposed plan that has not already been adopted in standard practice is the use of the brake for producing high-temperature water, under the corresponding pressure.

To show the practicability of the plan and the possible co-ordination of the various elements, it was decided to construct a demonstration unit large enough to give data on which to base the design of commercial plants. Accordingly, by courtesy of the Port of Bristol Authority, permission was obtained to erect such a unit at the Avonmouth Docks, England, using the docks as a tidal storage basin for the tides of the Severn estuary. This was a particularly suitable site, as the high tidal range permitted a considerable development at a relatively low cost. It also reproduced, on a small scale, approximately the conditions to be met in the development of electric power from the tides of the Severn.

The demonstration unit, Fig. 2, comprises a 300-hp. vertical propeller-type turbine with fixed guide vanes supplied with water from the docks through a 42-in. pipe. Coupled on the same shaft with the turbine is a brake, or heat generator, which is a modified Heenan & Froude dynamometer designed to operate under a pressure of 200 lb. per square inch. Above the brake and coupled to the same shaft is an alternating-current generator. This combination unit is shown in Fig. 3. A torsion meter on the shaft between the turbine and the heat generator is arranged to indicate the torque transmitted from the turbine. The reading of this

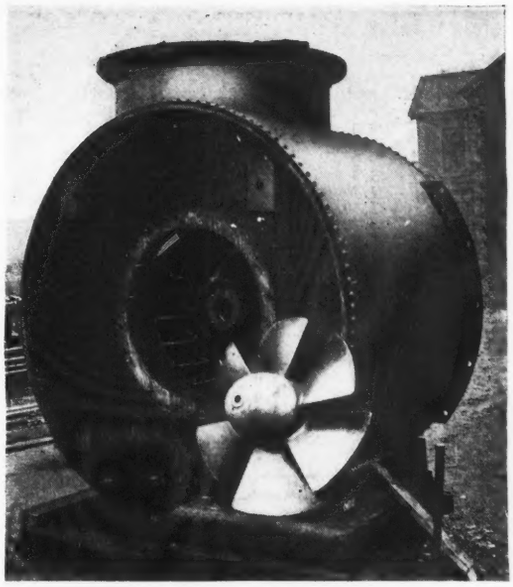


Fig. 5—Waterwheel used in the tidal power plant

instrument, in combination with the speed of the power unit, allows of determining the input to the heat generator and the alternator. The heat generator is connected to a steam accumulator having a normal capacity of about 25,000 lb. of water. Water circulation to the heat generator and pressure in excess of that in the accumulator is maintained by a centrifugal pump driven through gearing from the waterwheel shaft. There is no governor on the waterwheel, but one is provided to maintain a constant speed by increasing or decreasing the flow of water to the heat generator, and, consequently, the power absorbed by this element. The governor oil pump is connected to and driven by the shaft driving the circulating pump.

A steam turbine drives a high-speed alternator through a reduction gear. When required this alternator is operated in parallel with the one on the waterwheel. Figs. 3 and 4 show the general relation of the

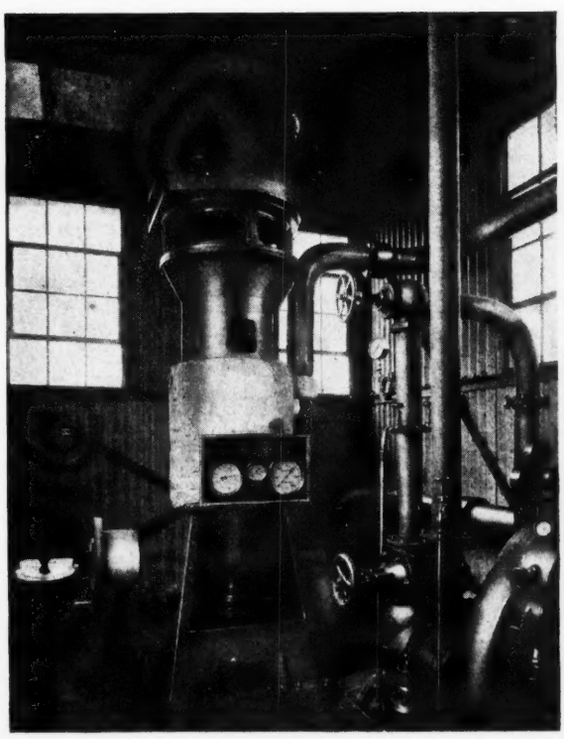
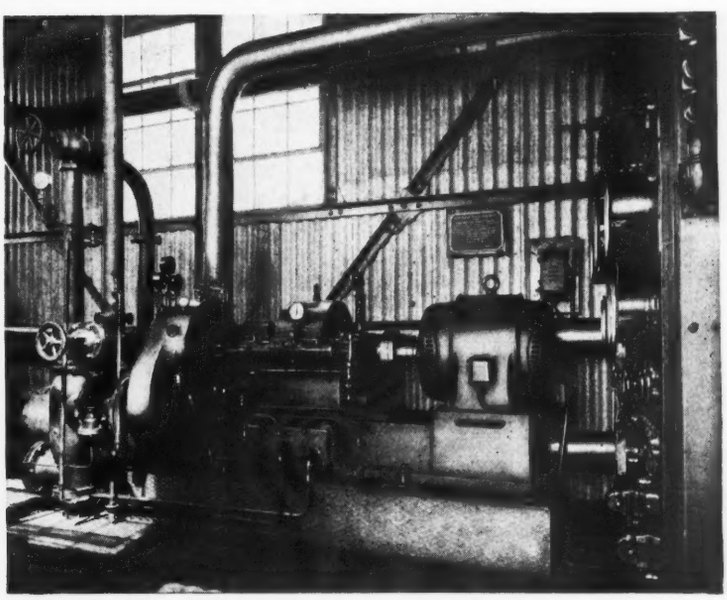


Fig. 3—(Left) At the top is the alternator and the water brake is back of the instruments

Fig. 4—(Below) Steam-turbine driven generator shown in its relation to the waterwheel driven unit in Fig. 3



TABULATED DATA TAKEN ON THE TEST STARTED AT MIDNIGHT, AUG. 26, 1930

Time	Dock Level, Ft.	Head Level, Ft.	Tail Level, Ft.	Working Head, Ft.	Torsion-Meter Output, Hp.	Summary Output, Hp.-Hr.	Heat Generator: Pressure Abs. Lb. per Sq.In.	Heat Generator: Corresponding Temp. Deg. F.	Heat Generator: Input, Hp.-Hr.	Elect. Load, Kw.	Summary Elect. Output, Hp.-Hr.	Total Input, Hp.-Hr.	Losses, Hp.-Hr
12.5	32.75	29.8	19.0	10.8	28.5	.....	44.7	274.0	.....	.....	.....	.....	.....
12.30	.....	29.3	14.5	14.8	39.0	15	46.7	276.6	27.0	.....	.....	27.0	12.0
1.00	.....	29.0	11.0	18.0	78.0	44	48.7	279.5	56.5	26.0	.....	56.5	12.5
1.30	.....	28.3	7.5	20.8	108.0	91	50.7	282.0	82.0	25.0	16.5	98.5	7.5
2.00	.....	27.7	4.0	23.7	155.0	157	54.7	286.5	125.5	24.8	33.0	158.5	1.5
2.30	.....	27.50	—0.0	27.5	183.0	241	59.7	292.5	186.0	23.8	49.0	235.0	—6.0
3.00	.....	27.20	—2.5	29.7	210.0	339	65.7	299.0	241.5	23.8	64.5	306.0	—33.0
3.30	32.4	27.0	—4.0	31.0	236.0	451	72.7	305.5	307.0	23.5	80.0	387.0	—64.0
4.00	.....	27.0	—5.0	32.0	243.0	571	82.7	315.0	401.5	24.0	95.5	497.0	—74.6
4.30	.....	26.9	—5.0	31.9	245.0	693	94.7	324.2	492.5	24.0	111.5	604.0	—89.0
5.00	.....	26.7	—5.0	31.9	245.0	816	106.7	333.0	583.5	24.3	127.5	711.0	—105.0
5.30	.....	26.7	—5.0	31.9	250.0	940	114.7	338.0	633.5	24.3	143.5	777.0	—163.0
6.00	.....	26.7	—5.0	31.9	250.0	1,065	126.7	345.5	707.5	24.32	159.5	867.0	—198.0
6.30	.....	26.7	—3.0	29.7	245.0	1,188	137.7	351.5	766.5	31.5	180.5	947.0	—241.6
7.00	.....	27.2	1.5	25.7	215.0	1,303	146.7	356.5	815.0	31.5	201.5	1,016.5	—286.5
7.30	.....	27.7	7.3	20.4	163.0	1,398	151.7	359.5	844.0	31.3	222.5	1,066.5	—331.5
8.00	.....	28.2	13.0	15.2	105.0	1,465	152.7	360.0	849.0	31.5	243.5	1,097.5	—372.5
8.30	31.5	28.8	19.0	9.8	35.0	1,500	150.7	359.0	839.0	8.12	252.0	1,091.0	—409.0
8.50	.....	29.7	23.0	6.7	15.0	1,510	148.7	358.0	829.0	.....	252.0	1,081.0	—429.0

heat generator and vertical alternator to the steam-turbine-driven unit in the plant. The steam for driving this turbine is obtained from the accumulator through a reducing valve by allowing the pressure in the storage system to drop through a specified range.

When the plant had been tested, a series of experimental runs was made. Certain minor mechanical difficulties developed, such as excessive leakage of glands; also, the governor linkages had to be modified. Further tests were then carried out, and they demonstrated that the system worked as expected. The method of governing proved to be accurate and sensitive.

The tests supplied data from which large installations can be calculated. The results agreed well with previous theoretical calculations. Of course, the actual efficiencies of such a relatively small plant cannot be as high as those to be obtained from commercial units. However,

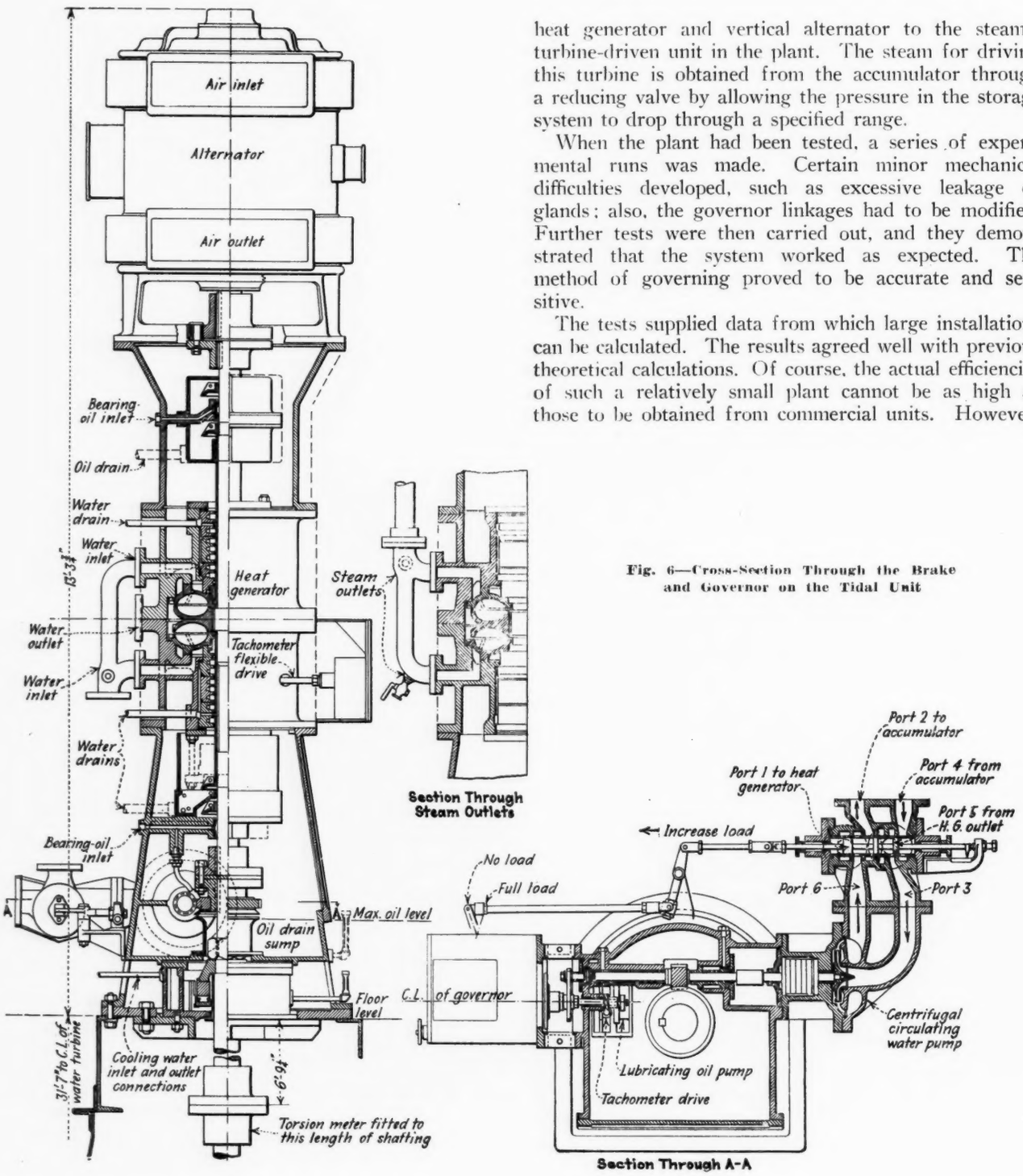


Fig. 6—Cross-Section Through the Brake and Governor on the Tidal Unit

calculation of larger units can be based on the data obtained, making suitable adjustments for the radiation and other losses.

The limiting factor of a hydro-thermal plant is the size of a steam accumulator container. Such containers have been built with a capacity of over 700,000 lb. of water, over 25 times larger than the Avonmouth accumulator.

The curves show a loss of 429 hp.-hr. in the first test, of 8.45 hr. duration, and 370 hp.-hr. in the second test, which lasted 8.20 hours. The table gives the data taken on the first test.

The losses per hour in the first case were 49 hp.-hr. and in the second test 44.5 hp.-hr., an average of about 47.25. These losses include heating of the system, which cools down over the inter-tide periods of four hours, but do not include the radiation losses of the accumulator over the same period, which is about 40 hp.-hr. The

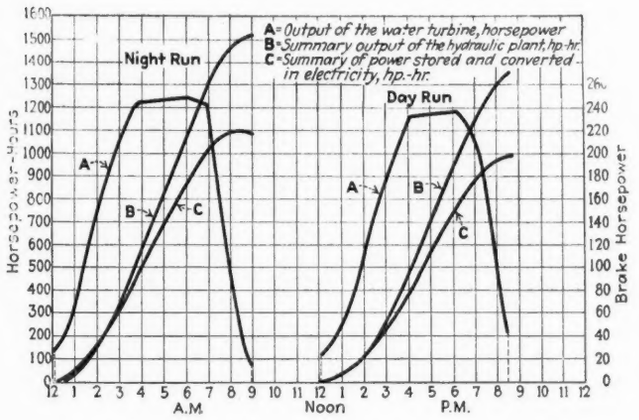


FIG. 7—OUTPUT CURVES OF THE WATERWHEEL-DRIVEN UNIT IN THE TIDAL PLANT

Curve *A*, the horsepower load on the waterwheel during its periods of operation for one day. Curve *B* is the accumulated power output in horsepower-hours of the unit as calculated from readings taken from a torsionmeter on the waterwheel shaft. Curve *C* is the accumulated output in horsepower-hours of the generator and the water brake, the latter being stored as heat in the water of the steam accumulator. The distance between the curves *B* and *C* represents the accumulated losses in the system in horsepower-hours. The table gives the data taken on the night run.

electrical losses of the waterwheel-driven generator are also included, and represent 25 to 26 hp.-hr. The thermal losses of the system are therefore $\frac{370 + 429}{2} + 40 - 25 = 415$ hp.-hr., and are distributed as follows:

Accumulator	140
Circulating system	80
Radiation from brake	100
Friction of glands	40
Gland leaks	55
Total	415

Studies are now being made of the possibilities of developing a tidal project under similar conditions to those on the Avonmouth plant by creating an artificial basin opposite the Avon on the Welsh grounds. The area of the basin would be 12½ sq. miles and the inclosing sea wall would cut off only the worthless part of Bristol Channel. This development would not interfere with the tidal flow or with navigation in the Severn, and is not likely to create opposition. Preliminary estimates give an investment of $30,000,000 as necessary for a development to produce 700,000,000 kw.-hr. per year at 50 per cent load factor and a peak of 160,000 kw. The cost per kilowatt-hour works out to be 0.44c., including capital charges of 6 per cent. This cost compares favorably with a coal-burning plant of the same capacity working under similar conditions.

A preliminary project has been worked out for the estuary of the river Rance in northern France. This project is to produce power and heat for a paper mill of 80,000 tons' yearly output.

Should High-Voltage Tests Be Applied to Old Equipment?

By MARIN PHILLIPS

THE application of high-voltage tests to old electrical equipment to determine its insulation condition is a question worthy of careful consideration. In one plant, having two hundred 3-phase, 60-cycle motors, ranging in size from 5 to 200 hp., it was the practice to subject the motors to a high-voltage test when they were taken out of service for cleaning, painting or repairs. The idea was to put no motors in service that were not believed to be in a first-class condition. This is desirable, but did their high-voltage test insure the insulation being in this condition? It is doubtful because motors continued to fail in service, notwithstanding the fact that 50 per cent of those tested, failed under the application of high voltage.

An indication that the system of testing with high voltage was wrong, was borne out by the fact that one motor winder and a helper was kept busy rewinding motors, when three failures per year would have been about the number to expect. In later years the megohm meter replaced the high-voltage test and rewinding costs were reduced about seventy-five per cent.

Another instance, where high-voltage tests are believed to have done considerable damage, was the testing of some 13,000-volt, 3-wire feeders. One of these cables failed in service, and it was believed that a high-voltage test between conductors and ground every three months, would reveal weak insulation without having it fail in service. However, three of the cables failed in one year during which time the tests were applied on schedule. This is pretty good evidence that the test was of no value and probably did a lot of harm. In fact, one cable failed one afternoon when the high-voltage test had been made on it the day before. This test showed the cable's insulation to be in good condition.

I believe that a high-voltage test will often break down a winding that would give several more years satisfactory operation at normal voltage. However, equipment that has just been rewound on a new cable installation should be given the recommended high-voltage test before being placed in operation. After the equipment has gone into service, giving it a reasonable amount of care and checking its insulation resistance periodically with a megohm meter is the best way to insure high reliability. Even if the insulation of an old machine does not fail under a high-voltage test it may be damaged to such an extent that it will break down shortly after going into service.

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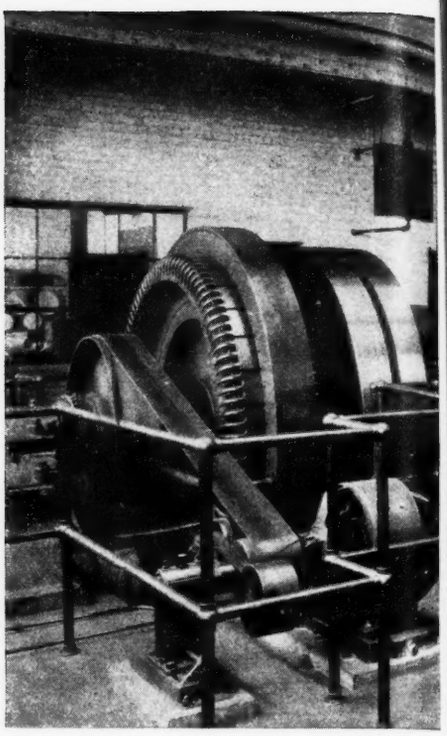


Revamping of the entire power system at the plant of the Atlantic Wire Company, Branford, Conn., with proper utilization of diesels, unaflow engine and exhaust steam, controlled by instrument and cost records, yields $5,000 to $8,000 net saving

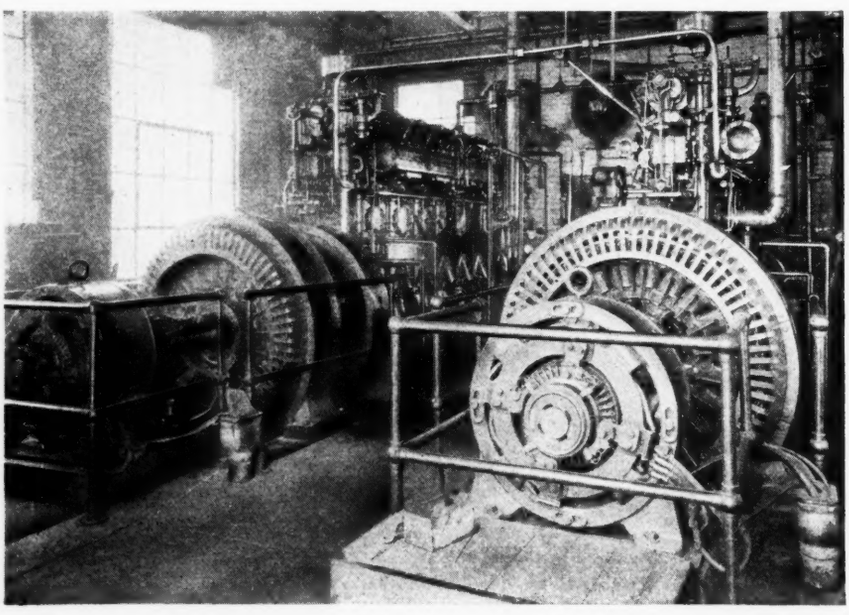
REPORTS of economics derived from operating diesel and steam units in parallel that have appeared recently in *Power* have been read by me with great interest, and I hope that we shall soon have operating figures from the latest of these installations.

Most of the reports have dealt with fairly large plants, where a constant demand for large quantities of power and steam seemed to justify such an arrangement. I believe it will be of interest to the readers of this magazine to learn of a comparatively small installation which nevertheless gives a very low power cost, is easily handled and is dependable and flexible in operation.

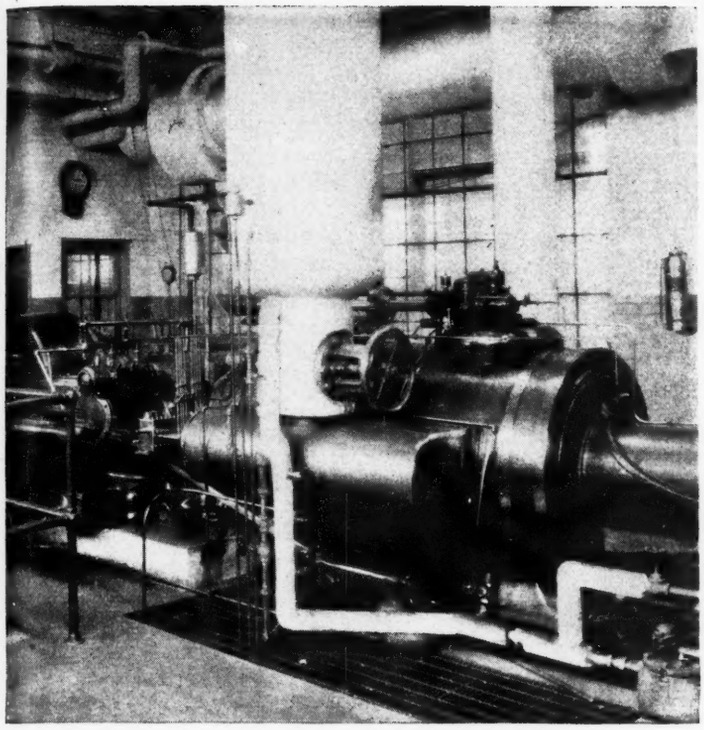
Originally, our plant consisted of a Fishkill corliss engine connected by belt to a lineshaft. Steam was generated in a Manning boiler at 90 lb. gage. Live steam was used for process work, for heating the office and for steam hoists. Exhaust of the engine at about 5 lb. back pressure was used for heating the mill. This was seldom sufficient; so that at times live steam had to be added. All electric power was purchased.

An increase in production also raised the demand for power; so two diesel engines, direct connected to alternating-current generators and exciters, were installed. But the power demand continued to grow; before long the diesels were running with 10 to 15 per cent overload, a very unfavorable condition.

Again we faced the problem of supplying more power. Installation of another and larger diesel, combined with a waste-heat boiler, was suggested. But after consid-

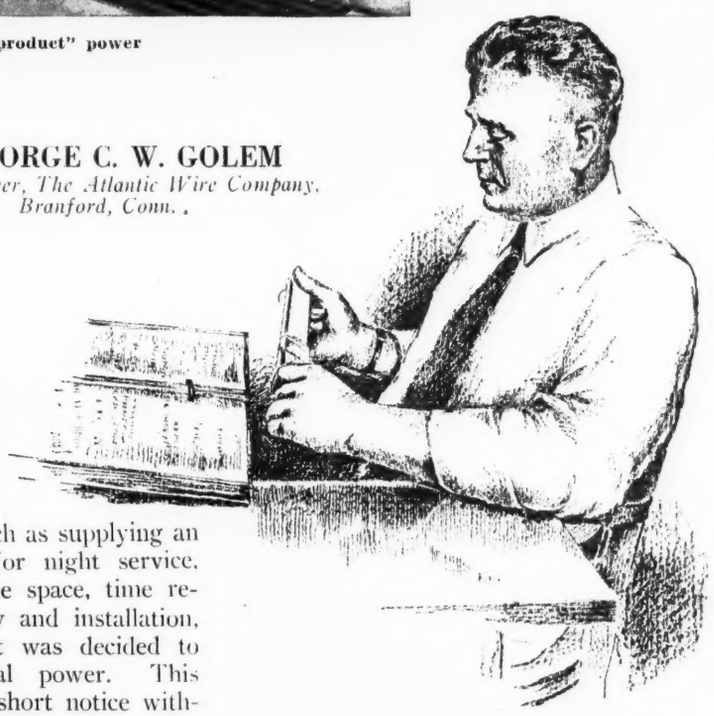


Two Diesel engines were installed



Unaflow engine generates "byproduct" power

By GEORGE C. W. GOLEM
Chief Engineer, The Atlantic Wire Company, Branford, Conn.



ering all points, such as supplying an auxiliary burner for night service, the lack of suitable space, time required for delivery and installation, and initial cost, it was decided to purchase additional power. This could be done on short notice without any investment of capital; so a 300-kw. transformer station was installed, which supplied part of the factory with power.

Even that proved to be not a very good solution for our power problem. The load in a wire mill is highly fluctuating, and as the diesels could not be run in parallel with the outside power it was impossible to adjust the load so that the engines would run at maximum capacity. The result was that considerably more power was purchased than was actually necessary.

While our power demand increased by leaps and bounds, our steam demand remained fairly constant until a change in process work and the contemplated remodeling of several departments made additional boiler capacity and relocation of the steam plant imperative, and I was requested by the management to submit a report and suggestions.

This did not seem to be so very difficult, as I had a fairly clear idea of what should be done; but when I came to the point where I had to figure the amount of steam then used and estimate the amount required I found myself up against it. The only records available were the monthly coal bills, and they seemed to be of little value to me. However, by dividing the amount of coal used between the day and night run and assuming an evaporation factor, I arrived at figures which proved to be close enough when later I checked them by actually weighing the feed water to the boiler.

Although this method was rather crude at best, it gave me a basis on which to work and from which to estimate steam requirements and probable savings and suggest changes. My proposals included the generation of steam at high pressure; the use of exhaust steam exclusively for process and heat; installation of an engine that would give us a maximum in power output from the amount of steam required by process and heat; and discontinuance of the purchase of power. I estimated that about $8,000 per year could thus be saved. (The actual amount saved comes very close to this figure, as will be shown later.)

My suggestions being accepted, the next problem was the selection of equipment. After receiving all required information from manufacturers, I took the matter up with our superintendent, and between us we decided what should be brought before the management for final approval. In selecting equipment we were governed by three major considerations: First, it should be adapted to our special requirements; second, it should eliminate as much manual labor as possible; and, finally, cost should be reasonable.

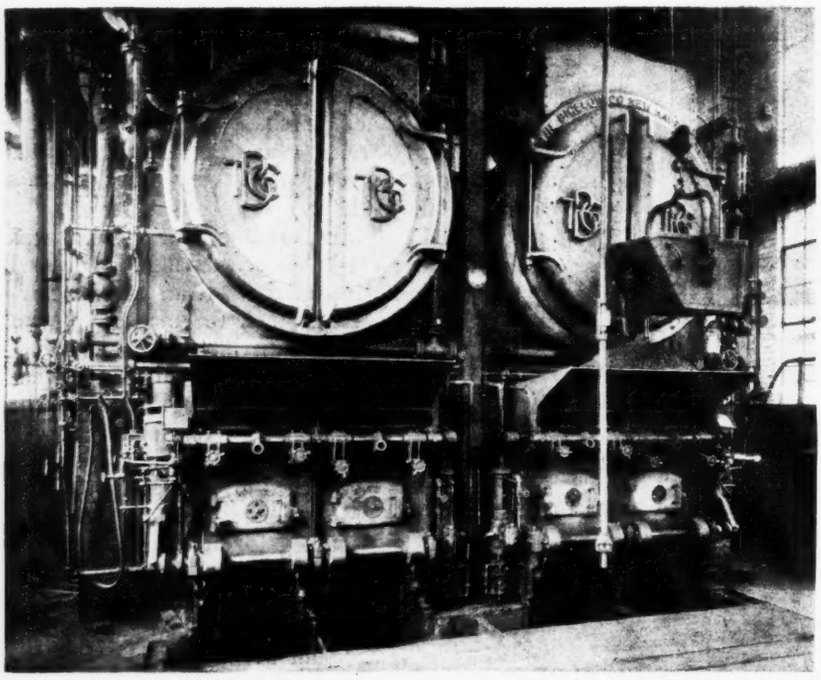
The most important item on our list was the engine. Looking over several designs, we soon found that a uniflow had the lowest steam rate for a wide range of load and therefore would give us the most kilowatt-hours from the steam used in the mill. Naturally, cost was a very important factor; so we looked over several used units offered for sale. We finally decided, however, upon a new engine large enough to carry the whole load if necessary.

We decided upon two stoker-fired horizontal-return-tubular boiler units of 1,674 sq.ft. heating surface each to operate at 170 lb. gage pressure. The question of superheat was also taken into consideration. But in view of the fact that the engine would have to run for some time at only 30 per cent of its rated capacity, and all the exhaust was to be used for process and heat, we concluded that the saving eventually to be derived from superheat did not justify the extra expense of installing a superheater at the time.

The stack was quite a problem, as we had very little space where we could place one. But a venturi-type stack solved our difficulties nicely; in fact, it has so far proved to be one of the best of our selections. Better

still, its cost, completely installed, was only 40 per cent of the price of a self-supporting steel stack of sufficient dimensions to provide draft for maximum boiler capacity.

Another difficult problem was that of coal handling. Coal is delivered to us by trucks. To reduce labor the installation of an overhead bunker with coal conveyor and automatic scales was first considered, but we found that the cost of such an installation was almost prohibitive for the size of our plant. Consequently, a 25-ton bunker space, partly below and partly above floor level, was provided in the boiler room. An overhead rail with hand-propelled electric hoist and a dump bucket were installed at about one fifth of the cost of the former.



The boilers are stoker fired

Every bucket of coal is weighed on a platform scale before it is put into the hopper. The whole installation works very satisfactorily.

To select the rest of the boiler auxiliaries, such as feed-water regulator, boiler-feed pump with governor, soot blower, damper regulator and closed feed water heater, was not difficult, and features of design and price decided either for or against each item. For example, the damper regulator was taken from the old boiler where it had done faithful service for fifteen years, reconditioned at the factory and connected to the throttle of the stack turbine.

To have always a sufficient amount of hot water available when a pickling vat is dumped, a hot-water storage tank of 2,400 gal. capacity, capable of heating 2,000 gal. per hour from 60 to 180 deg., was installed.

The only item of importance not so readily disposed of was the number and type of metering and recording instruments. Our final choice was as follows: One recording and one indicating steam-flow meter for each boiler, one recording flow meter for boiler feed water, one recording flow meter for exhaust steam to mill, one two-pen flue-gas temperature recorder, one steam pressure recorder, one feed-water temperature recorder and a four-pointer draft gage.

All recording instruments are mounted on an attractive slate panel in the chief engineer's office, while the indicating instruments are mounted on an ebony asbestos panel in the boiler room. No decision could be reached on a CO_2 recorder, but, by means of an Orsat, draft gage and flue-gas temperature recorder, we manage to run the boiler at fairly high efficiency.

Orifice plate and manometer connections were also installed in the auxiliary steam line and interconnected with the manometers from each boiler. As only one boiler is in operation at a time, the meter of the other boiler indicates and records the amount of steam used by the auxiliaries.

Full utilization of diesel cooling water was another interesting problem. Before the change the hot water from the jackets was returned through the mill. As the discharge line was rather long, the water from one of the diesels had to be wasted into the sewer during the summer months in order to keep the temperature low enough for safe operation.

An entirely new arrangement was provided. Water from the city main enters the plant close to the diesel engines, and the hot return goes into a concrete tank of about 5,000 gal. capacity, located in the boiler room. From this it is transferred by a small float-controlled rotary pump to a tank of 1,500 gal. capacity (picked from our junk pile), located close under the roof and about 22 ft. above floor level.

Diesels have their own building (center)

On top of the concrete tank, which is about 6 ft. above floor level, is a collecting tank for the returns. Into this tank, through a float-controlled valve, make-up water is supplied from the tank under the roof, which also keeps the hot storage tank filled. The elevation of the roof tank is sufficient to give the necessary head for a speedy flow through the mill, with supply piping of generous dimensions. A float valve near the bottom of the concrete tank admits water from the city main when the diesels are not running.

Equipment for the engine room was easy to select. The only difficult problem to be solved there was that

of the oil separator. Pickling vats are heated by steam blown directly into the solution. It is imperative that this steam be absolutely free of oil.

The separator first considered was quite heavy, was made only in a vertical design (not suited for our purpose) and was high in price. The sales engineer explained that due to the heavy impacts, which in our case would be 400 per minute, it was almost impossible to eliminate all the oil from the exhaust of a uniflow in an ordinary separator and that his was the only separator which could do it successfully.

After studying the problem for some time, we finally adopted the arrangement shown near the ceiling on the right in the view of the engine room on page 529. To an ordinary oil separator we attached a drum 24 in. in diameter and 14 ft. long. Some distance from the end, where the exhaust entered, we placed a baffle at such an angle that no recoil was possible. When completed,

Steam Cost for month of October 1929

Water 39634 cu.ft. @ 12¢/100		47.56
Chemicals 123 # compound @ 9¢		11.07
Coal 142.35 ts @ $ 6.05		861.00
Labor, operating		458.80
cleaning		32.79
Maintenance, labor		
repairs 13.95		13.95
Supplies, rags 10 # @ 16¢		1.60
cyl. oil 4 gals. @ 88¢		3.52
Fixed Charges		213.17
Total cost		$ 1643.46

Steam generated 3229 M# Boiler operated 692 hrs.
Load factor on rated capacity 58 %

Gross Cost per M# of steam 50.9 ¢
Net Cost per M# of steam 44.3 ¢

Distribution of Steam in M#.

Loss thru safety valves	38.3
Auxiliaries	348.00
Feedwater & hot storage	322.9
Process & heat	1961.00
Power	564.3

Report on Maintenance during month. Boilers.
1. One grate renewed in boiler # 2
4. Defective steam cylinder of boiler feed pump replaced by new one.
13. Regulating valve on stack turbine overhauled and packed.
16. One grate renewed in boiler # 2.
23. One grate renewed in boiler # 2.

Electric Power Cost for month of October 1929.

A. Diesel Engine.

Fuel oil 3958 gals. @ 5.44 ¢		$ 215.00
Lub. oil 72.5 " @ 78.1 ¢		56.00
Supervision		133.00
Maintenance, Labor 8.70		
Repairs 17.33		26.03
Supplies, rags 10 #@ .16 ¢		1.60
kerosene 5 gals. @ 14 ¢		.70
Packing		1.40
Fixed Charges		
Total cost		400.40
		$ 825.13

Kw.hrs. generated 42270 operated 270 hrs.
Load factor on rated capacity 61 %

Gross cost per kw.hr.	
Net cost per kw.hr.	1.953 ¢
Cost of fuel oil per kw.hr.	1.005 ¢
Cost of lub.oil per kw.hr.	.508 ¢
Cost of supervision per kw.hr.	.125 ¢
Cost of maintenance per kw.hr.	.314 ¢
Kw. hrs. per gal. of fuel oil	.0473 ¢
kw. hrs. per gal. of lub. oil	10.7
	583

B. Unaflow.

Steam 564.8 M# @ 50.9 ¢	
Supervision	$ 287.50
Labor, cleaning	123.57
Lub. oil 19.5 gals. @ 66 ¢	32.79
Cyl. oil 10 gals. @ 83 ¢	12.09
Maintenance, labor	8.30
repairs	
Supplies, rags 10 # @ 16 ¢	
kerosene gals.@ ¢	1.60
grease 2 #@ 40 ¢	.80
Fixed Charges	
Total cost	172.17
	$ 638.82

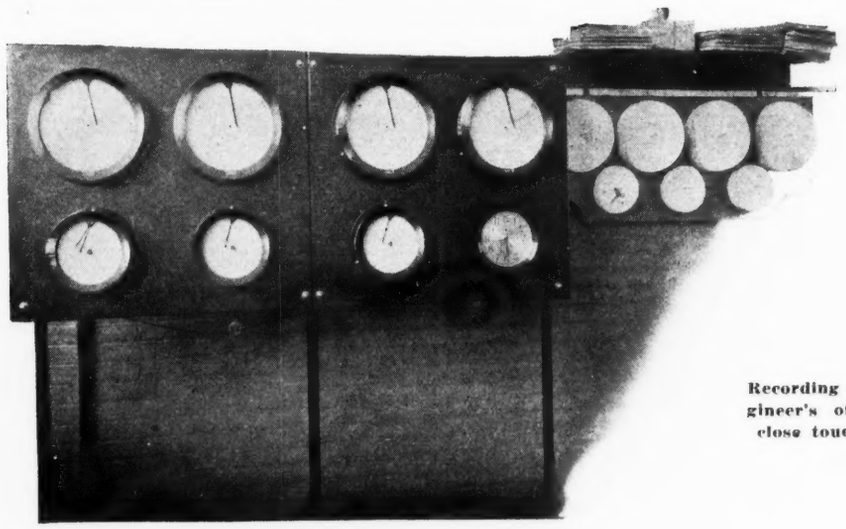
Kw. hrs. generated 39340 Eng. operated 490 hrs.
Load factor on rated capacity 27.54%

Gross cost per kw.hr. 1.625¢		
Net cost per kw.hr. 1.092¢		
Cost per kw.hr. on Diesel, gross 1.953¢ net 1.005 ¢		
Cost per kw.hr. on Skinner, gross 1.625¢ net 1.092 ¢		
Average cost, both units gross 1.789¢ net 1.048 ¢		
Power from outside	Power to B.H.T. Co.	
11.1. 30834	11.1. 108020	
10.1. 30430	10.1. 94748	
404 x 16		
6464 kw.hrs.	7272 kw.hrs.	

October 1929.
Report on Maintenance Work. Engines.
A. 9:30 - 9:50 forced shutdown on Diesel 1. Replace one brush on alternator.
12. Eng. 2 cyl. 5 one hand hole plate new gasket.
13. Rocker arm shaft taken out on Unaflow, bearing overhauled and adjusted. Oil tank on Unaflow cleaned, 10 gals. new oil.
19. All compressor valves on both Diesels taken out, cleaned and ground.
20. Diesel 1 cyl. 1 intake valve drawn, piston inspected. (Top is cracked thru.) Intake valve exchanged.
24. 7:15 - 8 am. Forced shutdown on Diesel 1. Gasket on hand hole plate blows out on cyl. 1, replaced. - Eng. 2 piston 1 exchanged, start 2 pm.
27. Fuel valves # 1 & 2 exchanged on Diesel 1. 2 new atomizers, one needle straightened.

Total Cost of Power.

Steam	
Diesel	1643.46
Skinner	825.13
Outside	351.37
Total	2819.96
Sold to B.H.T. Co.	3078.01
Actual Cost	260.84
Wire produced 2808920 # or 1404.5 ts.	2818.13
Cost per ton of wire produced $ 1.98	
Pounds of wire per kw.hr. 34.763	



Recording instruments in engineer's office keep him in close touch with operation

Sample Power Cost sheets. Difference between total unaflow cost on second and third sheets explained on page 533

the whole arrangement weighed only half as much as the separator first considered, and the cost was only about 30 per cent of the other. So far the results obtained have been excellent.

Besides having a steam separator, the engine is provided with an automatic stop system which protects against damage by overspeed or water.

To facilitate the handling of engine parts during installation and maintenance, a hand-operated traveling hoist of one ton capacity was installed in the engine room.

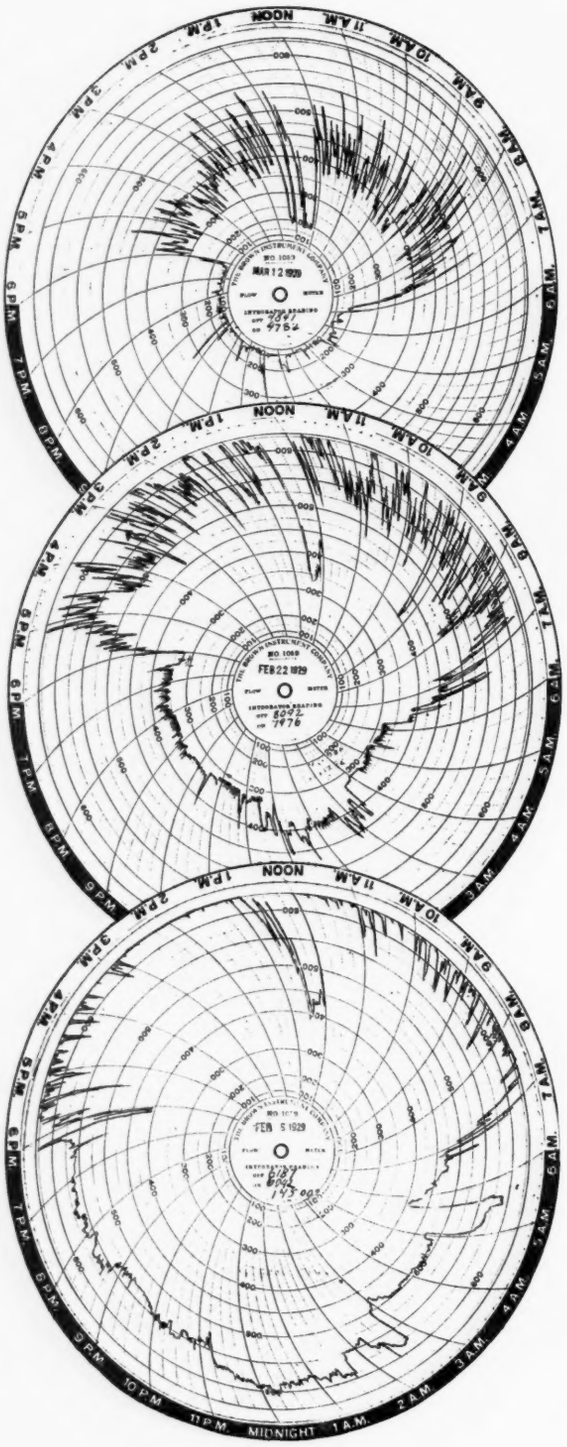
The plant was laid out and equipment arranged in the same manner as it was selected. A general contractor broadly experienced in power plant work was employed to erect the building, auxiliaries and piping according to our suggestions. The result is an up-to-date plant with an abundance of daylight everywhere well ventilated and with sufficient elbow room. Needless to say, the tops of the boilers were heavily lagged, all piping (including hot storage and feed water heater) was well insulated and a very neat job was made of it.

On Nov. 1, 1928, the new plant was started, but the operation was far from being undiluted bliss. It took some time before equipment as well as men had been induced to perform efficiently. Now the whole plant (boilers, diesels and uniflow), a total of about 900 hp., is run and taken care of by one man on shift, with a part-time laborer who takes out the ashes and does some sweeping and cleaning up.

As the changes in the mill had not been completed when the new plant began operation, the old engine had to be run with steam supplied from the new boiler plant. It was shut down for good in September, 1929, and then we began to figure the savings derived from our new installation.

In the meantime I had worked out a power cost system. While no claim is made that this system is perfect, it suits our conditions and has been approved by the management. (See records for month of October, 1929, reproduced on page 531. This month was chosen as one of normal business conditions.)

According to this system, the total cost of steam gen-



Steam flow charts showing economies effected in process steam use **(see page 533)**

Principal Equipment

Boiler House

Boilers, 2, 1,674 sq.ft., h.r.t.	Bigelow Co.
Boiler setting	Joseph Meade & Son
Stack, Thermix	Prat-Daniels Corp.
Stack, fan turbine, 20 in.	Coppus Engrg. Corp.
Soot blowers, 2	National Flue Cleaner Co.
Stokers, 2, Huber automatic	Flynn & Emrich Co.
Damper regulator, 1	Spencer Regulator Co.
Coal-handling equipment	Cleveland Tramrail Co.
Boiler feed pump	Worthington Pump & Mach. Corp.
Boiler feed pump, governor	Copes' Northern Equipment Co.
Feed-water regulators, 2	Copes' Northern Equipment Co.
Blowoff valves, 2	Everlasting Valve Co.
Temperature regulators, 3	Fulton Sylphon Co.
Feed-water heater, closed	National Pipe Bending Co.
Hot water storage heater	National Pipe Bending Co.

Engine Rooms

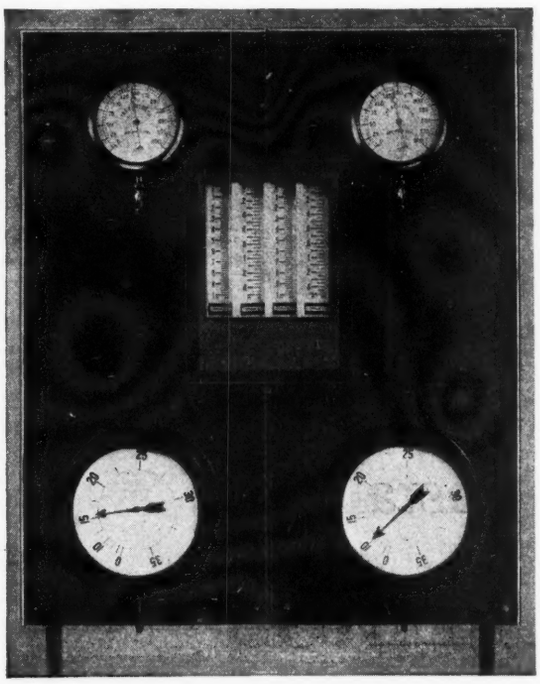
Diesel engines, 2, 200-b.hp., 6-cyl. 9½x13½-in., 4-cycle air-injection, 360-R.p.m.	The Lombard Governor Co.
Generators, 2, 200-kva., a.-c., 240-volt, 3-phase, 60-cycle	Westinghouse Electric & Mfg. Co.
Exciters, 2, 10-kw., 125-volts	Westinghouse Electric & Mfg. Co.
Skinner Universal Unaflow, 1, 23x24 in., 200-r.p.m., 150-lb. gage throttle pressure, 5-lb. back pressure	Skinner Engine Co.
Generator, 1, 365-k.v.a. a.-c., 240-volt, 3-phase, 60-cycle	General Electric Co.
Exciter, 1, 14-kw., 125-volt, 900-r.p.m.	General Electric Co.
Switchboard	Westinghouse Electric & Mfg. Co.
Voltage regulators, 2	Westinghouse Electric & Mfg. Co.
Oil purifier	De Laval Separator Co.
Steam separator	Ludeman Bros.
Automatic stop system	Ludeman Bros.
Oil separator	National Pipe Bending Co.

Miscellaneous

Flow meters, 4 recording, 2 indicating	The Brown Instrument Co.
Temperature recorders, 3	The Brown Instrument Co.
Draft gage, four-pointer	Ellison Draft Gage Co.
Safety valves	Crosby Steam Gage & Valve Co.
Non-return valves	Golden-Anderson Valve Specialty Co.
Back-pressure valves, multi-port	Cochrane Corp.
Traps	Cochrane Corp.
Header and manufactured piping	Whitlock Coil Pipe Co.
Piping installation	G. W. Cawley Co., Inc.
Heat insulation	Lotz Asbestos Co.
General contractor	G. W. Cawley Co., Inc.

erated by the boiler is computed first. The loss through safety valves and the amount used to heat the feed water and hot storage is estimated. This sum, plus the quantity recorded by the flow meter for steam to auxiliaries and exhaust to mill, is subtracted from the total amount of steam generated by the boiler. The remainder is charged to power.

It is then an easy matter to compute the cost per kilowatt-hour. In the records shown on page 531 the "gross" cost per kilowatt-hour is the total cost including all fixed charges and equipment maintenance. The "gross" cost on the diesel was 1.953c. per kilowatt-hour. On the uniflow it was 1.625c., giving a straight average of 1.789c. for both units. The "net" cost per kilowatt-hour was 1.005c. for the diesel and 1.092c. on the uniflow, giving a straight average of 1.048c. for both units. In figuring the "net" for the uniflow the total cost of $638.82 was reduced by $172.17 for fixed charges on engine equipment and by an additional $37.29 for fixed charges in cost of steam used.



Boiler-room gage board

Savings for the month were computed as follows: From the record it will be seen that a total of 88,070 kw.hr. was consumed during the month. This amount, if purchased, would have cost us about $2,150. To this must be added the cost for steam, which would have been $1,360, making a total of $3,510. The actual cost, including all charges for overhead and maintenance, was $3,073, saving of $437 per month, or $5,250 per year.

It will be noted that the total uniflow power cost is given as $638.82 on the second record sheet of page 531, while the presumably identical "Skinner" cost on the third sheet is given as $351.32. The former value is correct. The other has been reduced to take account of the fact that the total uniflow power cost includes some of the steam cost included on the first sheet. The correction is applied at this point for convenience and gives the correct figure of $3,073.01 (third sheet) for the total power cost.

When it is taken into consideration that the uniflow was running at only 27 per cent of its rated capacity, that the estimated amount of steam for process work had not been reached at that time, that not much steam was required to heat the mill in October, and that some power is still bought, it will be realized that the estimated saving of $8,000 a year will be closely approached under normal conditions.

As previously stated, the changes in the mill had not been completed in October. For example, live steam was still used for process work. Progressive improvement in steam utilization is shown by the three charts on page 528. The amount used can clearly be seen from the night run of Feb. 5. (Steam during day run includes amount used by old engine.) By Feb. 22 the change had been completed, but still more steam was used than was considered necessary. Thermostatic controls were then installed, and the result can be seen from the chart of March 12. Thermostat control was also installed on the diesel engines. Beside saving about 20,000 gal. of water a day during the summer (somewhat less in winter), these permitted running engines at a much higher temperature (130 to 140 deg., against 100 deg.) thus increasing their efficiency considerably.

A very important feature of our diesel-steam operation is that all peaks and sudden changes in the load are taken by the steam engine; so that the diesels are run at almost constant load.

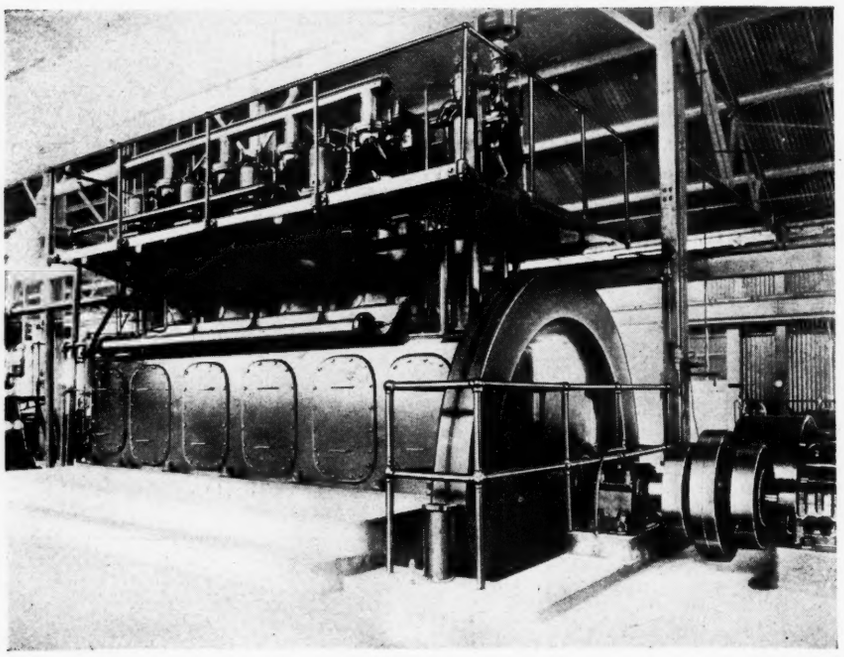
In conclusion, there remains for me the pleasant duty of expressing my heartiest thanks to W. E. Hitchcock, president of the Atlantic Wire Company, who, when asked for permission to use our records for publication, granted this request by saying, "Anyone who can benefit by our experience is welcome to it."

How Heavy Is Steam?

ALL engineers know that steam is much denser at high pressures than at low, but the enormous range existing within the limits of present day power practice is not always appreciated. Commercial practice in America today extends from 1,400 lb. (call it absolute for simplicity) down to at least 29 in. vacuum, or one half pound absolute.

At the upper limit, according to the new Keenan steam tables one cubic foot of steam weighs 3.35 lb. Conversely one pound of steam at this pressure occupies a volume of only 0.2983 cu.ft. If this same weight (one pound) is expanded to dry saturated steam at one half pound absolute pressure its volume increases to 642 cu.ft. The ratio is 2,150.

If steam in the high-pressure main and in the condenser connection were dry saturated and if equipment were designed for the same steam velocities at both points the free areas would have this ratio. Actually the ratio is considerably less because the throttle steam is superheated and the exhaust steam is wet. For example, if the 1,400-lb. steam is superheated to 750 deg. F., its volume per pound is 0.4365 cu.ft. instead of 0.2983 cu.ft. Moreover practical considerations make it necessary to permit higher steam velocities in the exhaust connection. After making allowances for all of these factors there is obvious justification for the enormous enlargement in size of parts as one progresses from the high-pressure steam main to the condenser connection.



Diesel engine connected to oil-pipe-line pump by flexible disk-type coupling

Selecting and Installing FLEXIBLE COUPLINGS

Most of the troubles experienced with flexible couplings can be eliminated by selecting the right size and type for the job, and by giving them a reasonable amount of care after they have been properly installed

By F. A. ANNETT
Associate Editor of POWER

PROPER ALIGNMENT of machines is a problem that is always with designing, erecting, and operating engineers. The designing engineer must provide means to properly align machinery and keep it in alignment. He must also design suitable foundations, so that when equipment is correctly installed it can with a reasonable amount of attention be kept lined up. One of the important parts of the erecting engineer's job is to set the different machines comprising an installation in good alignment. When machinery is installed and turned over to the operating engineer, he should check the equipment at regular intervals to see that it does not get out of alignment to an excessive amount.

If practically perfect alignment could be obtained and maintained, a rigid coupling would be the ideal way of connecting two shafts together for most installations. Even when two machines are mounted on the same bedplate and foundation this ideal alignment cannot be maintained. Settling of foundations, changes in temperature, wear of bearings, and other causes throw machines out of line. Thus, the need for using flexible couplings to allow a reasonable amount of misalignment.

Two shafts out of line, when rigidly coupled together, have severe bending stresses set up in them. This bending action may cause a shaft to fracture by fatigue. Such failures are not uncommon, and some occasion disastrous results. Shafts out of line make it difficult to lubricate bearing, and cause high bearing temperatures and excessive power losses. These conditions can be eliminated to a large degree by using flexible couplings.

Where the driven load or reduction gears produce considerable vibration, or where there are sudden shocks developed by the load, the full effects can be prevented from being transmitted to the motor by the proper type of flexible coupling. Where conditions are such that loads may develop beyond the safe capacity of machine parts the flexible coupling can be designed to act as a safety device as shown in Fig. 2. In this design, one flange of the coupling is loosely mounted upon its hub, the latter being keyed to one shaft. The hub and flange are held together by bolts that have a reduced section and are designed to shear at a predetermined overload. When an excessive overload occurs the bolts fail and allow the coupling to rotate within the flange and the machine is relieved before serious damage is done. After the trouble has been corrected, new bolts are put into the coupling and the equipment is put back into

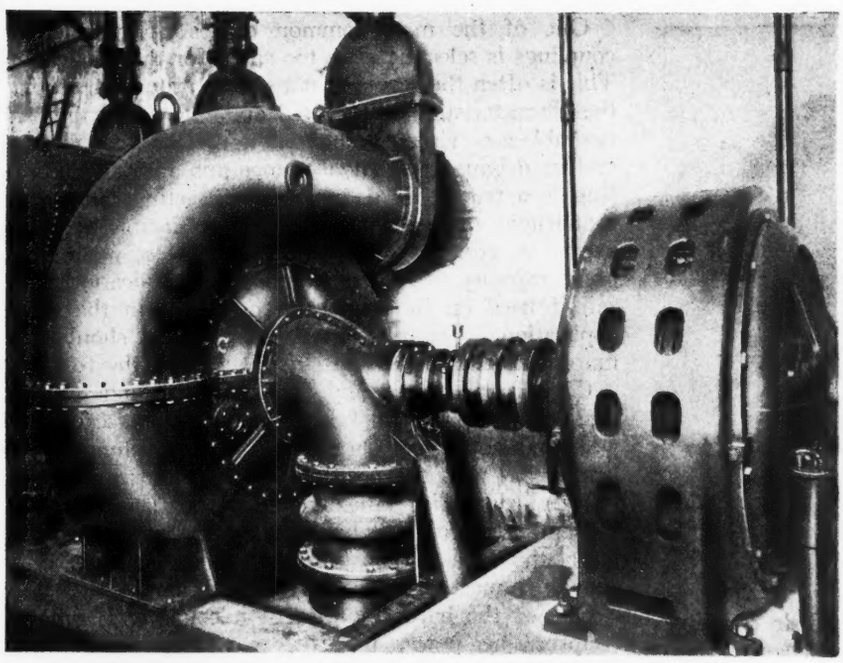


Fig. 3—Motor connected to centrifugal pump by an internal - external gear - type flexible coupling

service. This arrangement confines the failure to the least expensive parts and to those that can be most easily replaced. Obviously, flexible couplings have two functions to perform: To take care of misalignment and to operate as a safety device.

The statement that flexible coupling will take care of misalignment should not be taken to mean that proper alignment of shafts can be neglected when these couplings are used. Quite the reverse is true. Shafts should be just as carefully lined up for flexible couplings as when the solid type is used. The purpose of a flexible coupling is not that of a universal joint or a compensator for gross errors in misalignment, as is frequently assumed. When a flexible coupling is substituted for the solid type, a block of metal has been replaced by a machine with moving parts. Like any machine, the more a flexible coupling has to work the greater will be the wear. If shafts are allowed to operate with an excessive amount of misalignment the wear on the coupling will be unnecessarily high.

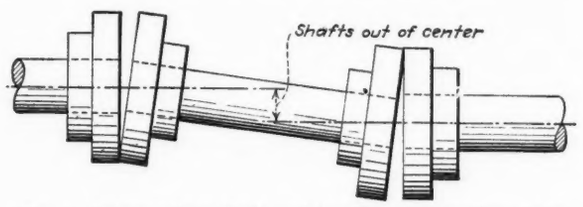


Fig. 1—Intermediate shaft and two flexible couplings take care of excessive misalignment

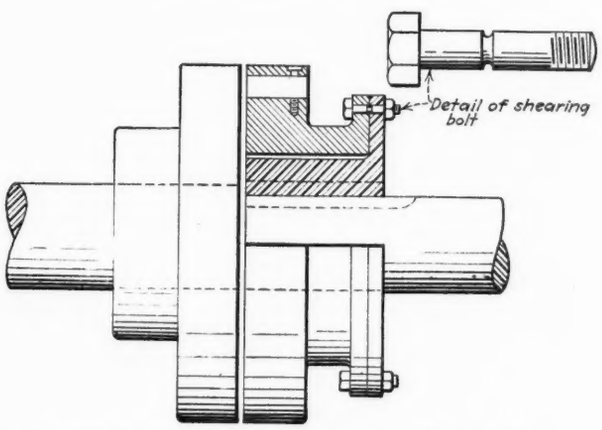


Fig. 2—Safety-type flexible coupling provided with shearing bolts

There is a limit to the amount of misalignment for which any coupling can compensate. If a motor and its driven machine are put into service out of line by an amount equal to one-half that which can be taken care of by the coupling, not only will the wear on the coupling be unnecessarily high, but one-half of the coupling's capacity to take care of misalignment is lost before it goes into service. If the drive happens to be one that is difficult to keep in line, it may in a short time reach the limit where it will damage the coupling. No coupling has been developed that is a substitute for good shaft alignment.

Where excessive misalignment must be taken care of, a double-coupling combination, Fig. 1, or a floating ring-type coupling, Fig. 4, should be used. Such double-coupling arrangements will take care of about $\frac{3}{64}$ in. out-of-center shaft misalignment for each foot of intermediate shaft. However, in any case due care should be taken to obtain good initial alignment of the connected machines. This will provide greater capacity for taking care of subsequent operating misalignment.

All types of couplings are not suited to the double combination, Fig. 1, since the intermediate shaft must be held so that it will not develop a whipping action. Couplings the flexible members of which are of laminated metal or fabric disks have been used extensively for this service. These couplings form a rigid support of the intermediate shaft and are flexible to take care of the angular misalignment of two machines.

When selecting flexible couplings for a given application there are many factors to be considered. One of the first and most important is size. Couplings are usually rated in horsepower per 100 r.p.m. A coupling rated 5 hp. at 100 r.p.m. will be good for 25 hp. at 500 r.p.m. This rating is based on the most favorable operating conditions, such as an electric motor driving a blower or a generator that supplies a fairly constant load. Conditions of load and drive vary widely and service factors must be used. The table lists the service factors used by one flexble coupling manufacturer. These cannot be taken as standard, since other manufac-

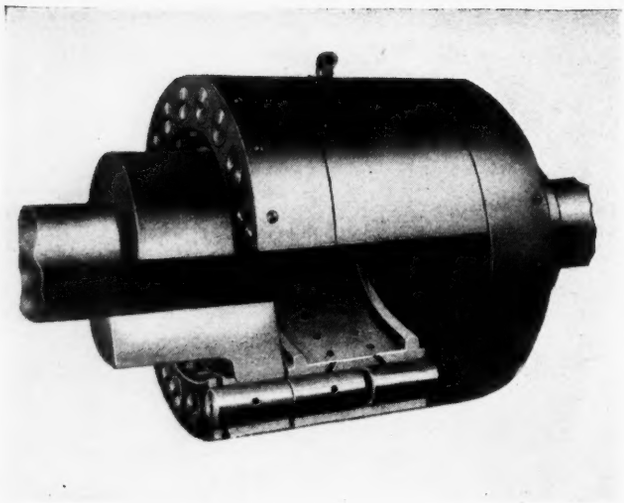


Fig. 4—Double floating-ring flexible coupling to take care of excessive misalignment

turers use different service factors for their couplings, which can be obtained from makers' catalogs.

The capacity of a coupling in horsepower per 100 r.p.m. required for a given application can be determined by the formula:

$$Coupling\ rating = \frac{Hp \times F \times 100}{S}$$

Where Hp = The horsepower to be transmitted.
F = The service factor.
S = Speed in r.p.m. of the coupling.

Take the case of selecting a coupling for a 25-hp., 850-r.p.m. motor driving a belt conveyor. A service factor of 2 is given in the table for this drive. Then the coupling will have a rating at 100 r.p.m. of $\frac{25 \times 2 \times 100}{850} = 5.9$ hp., say 6 hp. The size of the shaft on which the coupling is to be used must also be taken into account. If, after checking up on the coupling's dimensions, it is found that the maximum bore of the 6-hp. size is smaller than the shafts on which it is to be used, a coupling should be selected, the bore of which equals the diameter of the shafts on which it is to be installed. When selecting a coupling it is well to err on the side of sufficient capacity, as there is little possibility of trouble from that cause. Couplings too small have high maintenance and may have to be replaced.

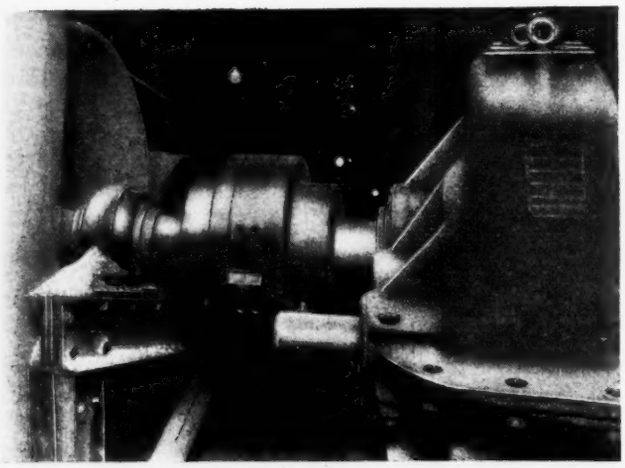


Fig. 5—Modified type of Oldham flexible coupling connects reduction gear to belt conveyor

One of the most common causes of trouble with couplings is selecting sizes too small for the applications. This is often the result of not giving proper attention to the characteristics of the load and the power unit. In the table a service factor of 1.5 is used for couplings on motors driving centrifugal pumps and fans. When the load is a triplex or a duplex direct-acting pump, or a centrifugal dredge pump, a service factor of 3.5 is used. A coupling that would connect a motor of a given capacity to its load in the first application would fail if used on the same size of motor in the second application. For the latter the coupling should have more than double the capacity required in the former.

Centrifugal pumps and fans, as used under normal conditions, represent a fairly steady load and cause little wear on a coupling. On the other hand, a plunger pump load varies with the position of the pistons and is continually subjecting the couplings to shocks. Consequently, the coupling has to withstand more wear than when the load is constant and must be made large enough to meet the more severe conditions.

One of the hardest duties of a coupling is where a reciprocating power unit drives a reciprocating load, such as a steam engine driving a compressor. Here the coupling is subjected to shocks from the power source

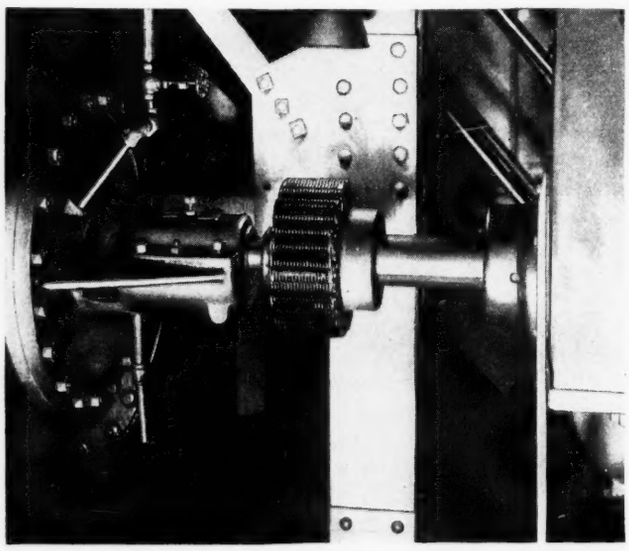


Fig. 6—Silent-chain coupling connects 100-hp. motor to condenser circulating pump

and from the load, and must be selected of a size that will fill this service. In this instance, the table recommends a service factor of from 9 to 11, the higher factor being used for the most unfavorable condition, such as where a single-cylinder engine drives a single-cylinder compressor.

When in doubt about the proper size of coupling it is advisable to take the matter up with the manufacturer. The manufacturer should be told the kind of machines to be connected, the horsepower and speed of the machines (both normal and maximum if there is considerable variation) and the size of both shafts and keyways. Any special conditions should also be included, such as a flywheel, if used, and its location; reversing service; how frequent are the reversals; space limitations; unusual temperatures; excessive moisture and fumes, etc.

Where a coupling is to be used in reversing service this must be taken into consideration when selecting it. Couplings that have considerable back lash should not

SERVICE FACTORS FOR FLEXIBLE COUPLINGS

		Service Factor
Turbine	Centrifugal pumps and fans	1.25
Turbine	Generators	1.5
Motor	Centrifugal pumps and fans	1.5
Motor	Belt conveyors, bucket elevators, smooth-load grinders and generators, factory lineshafts, light woodworking machinery, etc.	2
Motor	Triplex and duplex direct-acting pumps centrifugal dredge pumps	3.5
Motor	Screw conveyors, hoists, cranes, crushers, tube mills, pulverizers, hogs (steel, rubber and brass rolling mills), pulverized-fuel pumps, wood planers and surfacers	4
Motor	Compressors, well-drilling rigs	6
Engine	Centrifugal pumps and smooth-load generators	3
Engine	Centrifugal dredge pumps and variable-load generators	5
Engine	Triplex and duplex direct-acting pumps	5 to 6
Engine	Fans	8
Engine	Compressors	9 to 11

be used in this application. If the reversals are frequent, proper allowance must be made to obtain a coupling large enough to stand the service. Where couplings are used on equipment subjected to a braking action, such as on hoists and cranes, account must be taken of these conditions and a proper service factor used.

In addition to selecting a coupling large enough for the application, local conditions must be taken into account. Where high temperatures are encountered couplings must be selected that will operate under them. Couplings that will operate successfully when the surrounding air is fairly clean may fail if abrasive dust is present. Several types of coupling can be made suitable for dusty conditions by inclosing them to operate in an oil bath. Excessive moisture and acid fumes in the atmosphere and any other adverse conditions must be taken into consideration if the best type of coupling is to be selected.

Flexible couplings for most applications should compensate for both parallel and angular misalignment. Couplings in which the flexible member is rubber or springs have tangential flexibility, and to a degree will prevent shocks being transmitted from the load to the source of power.

Most couplings possess axial flexibility, that is, allow end play of the connected shafts. Some couplings possess this characteristic to a greater degree than others. Special designs may be had to meet unusual conditions. For example, to take care of the end adjustment of a Jordan plug, couplings are made that will allow 12 in. of endwise movement.

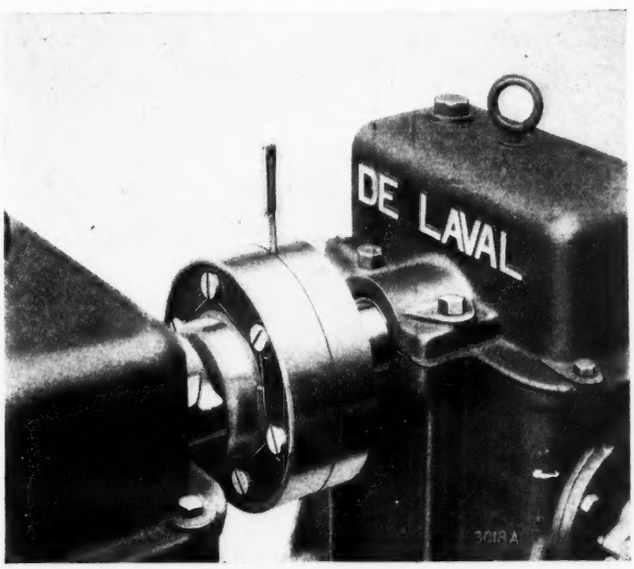


Fig. 7—Checking angular alignment with leaf gage between coupling flanges

Under some conditions certain characteristics in a coupling may be objectionable. If the coupling has considerable tangential flexibility there is a possibility of resonance being set up between the elastic members of the coupling and the pulsations of the load or the source of power, if either or both have reciprocating characteristics. These oscillations may increase in intensity to where they will damage the coupling or cause other objectionable effects. This condition is an exception and need only be considered where the pulsations are severe.

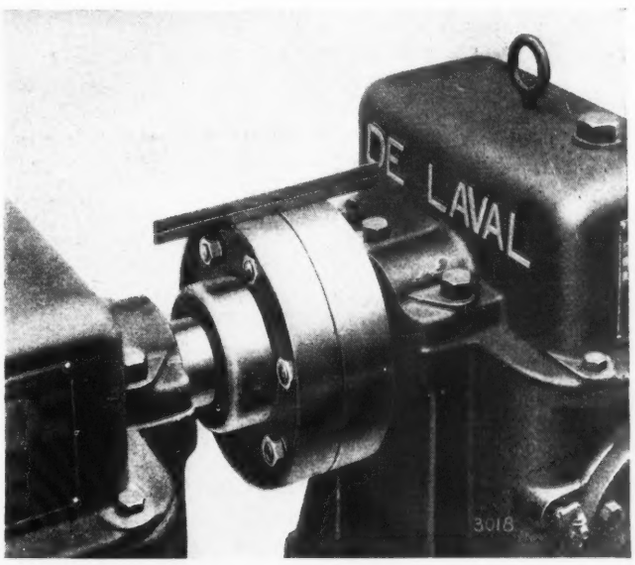


Fig. 8—Parallel alignment checked with steel straight edge placed on the two halves of the coupling

In most cases of a pulsating load tangential flexibility will assist in preventing load shocks being transmitted to the prime mover.

Where the speed of couplings required exceeds those listed, the manufacturer should be consulted. A coupling that may be satisfactory on a slow-speed shaft may wear rapidly, be noisy, and be otherwise objectionable at high speeds.

As previously mentioned, shafts should be kept properly aligned when flexible couplings are used, as when solid couplings connect the shafts. Because machines are mounted on the same bedplate does not insure their being in line, since the heaviest bedplates can be distorted by improper installation. When machines are first installed they should be placed in good alignment. High-speed machines should be lined up to within 0.002 to 0.004 in. For slow-speed shafts 0.01 in. is good practice.

A simple method of checking the alignment of the two halves of many couplings is that shown in Figs. 7 and 8. First a leaf or feeler gage is inserted between the two halves of the coupling, as in Fig. 7. The space should be practically uniform all around the coupling. When checked on each quarter this space should not vary more than 0.002 in. To check the out of center alignment of the shafts a steel straight edge is placed on the surface of the coupling, as in Fig. 8. This check should also be made at each quarter on the coupling. The straight edge should make an even bearing on the two halves of the coupling at all positions. These checks are easily applied and should be made frequently enough to locate any excessive misalignment before it can damage the coupling.

NIAGARA'S LARGEST PLANT COMPLETED

Queenston plant contains ten 58,000-hp. units. Nine of the generators have an open system of ventilation and the tenth unit uses a closed system with air coolers. A carbon-dioxide fire-protection system is provided

By JOHN R. DUNBAR
Engineer
Canadian Westinghouse Company

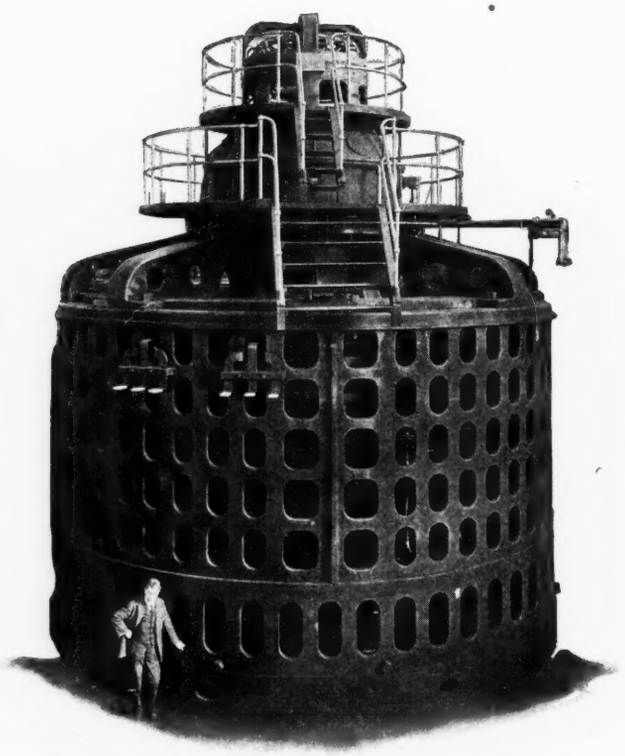


Fig. 1—Generator for Unit No. 10 in the Queenston plant

WITH THE INSTALLATION of the tenth 58,000-hp., waterwheel-driven generator at the Queenston generating station of the Hydro-Electric Power Commission of Ontario, the water-power development at Niagara Falls is practically complete, until a new international agreement permits the use of more water for power purposes.

As the amount of water available for power purposes at Niagara Falls is controlled by treaty rights and is not affected by precipitation and storage, all the Hydro-Electric Power Commission's plants at Niagara Falls are operated at as high a load factor as possible. On account of its high efficiency, the Queenston generating station carries as much as possible of the steady load, the other plants taking the peaks or excess demand. The load factor for the plant throughout the year is over 80 per cent.

For several years after the Queenston plant was put into operation the maximum peak load during the year has been practically equal to the total installed capacity of the station. In the last few years, however, with the nine units in operation, the peak has exceeded the total rated capacity of the station. After extended investigation of economy and preparation of estimates the installation of the tenth unit was proceeded with. The nominal rating of this machine is 55,000 kva., 12,000 volts, 80 per cent power factor, 3 phase, 25 cycle, 187½ r.p.m. The first machines installed in this plant were rated at 45,000 kva., 12,000 volts, with a maximum rating of 49,500 kva. at 13,200 volts. When the machines had been installed and tested it was decided that they could be rated up to 55,000 kva. with a corresponding increase in the maximum rating, without extensive changes in the design. Accordingly, when additional machines were ordered they were rated at the higher capacity and a larger section of field copper was used in order to keep the excitation voltage down. The 55,000-kva. generators are practically duplicates of the 45,000-kva. units. These have been described by R. A. McCarty and H. U. Hart, in the *Transactions,* A.I.E.E., Vol. XLI, 1922, page 496.

On account of the high value of flywheel effect specified (21,000,000 lb. ft.^{2}) it was necessary to employ a very heavy type of construction. The spider is of the laminated-rim design which the Canadian Westinghouse Company use for practically all waterwheel-driven generators. The design used has an inner cast-steel spider consisting of a hub and arms but no rim. The laminated rim is built up of $\frac{1}{16}$-in. rolled-steel plates. The runaway speed for which the machines have been designed and tested in the power house is 185 per cent of normal speed. The frame construction is of the ordinary cast-iron box type as may be seen in Fig. 1, which shows a shop view of the machine. Although new designs of generators call for fabricated steel frames and brackets, this machine was being installed in a station in which all the existing machines had cast-type frames and, for uniformity, it was desirable to maintain the same con-

struction. Furthermore, when all the patterns are available, the structural-steel construction shows very little saving compared with the cast-iron construction on machines of this size.

As on the previous machines supplied by the Westinghouse company, the total weight of the generator rotor, the turbine runner, and the unbalanced hydraulic thrust, is carried on a Kingsbury thrust bearing supported on the top bracket.

The armature coils are insulated with micarta folium insulation using mica tape on individual strands and conductors and a machine applied paper and mica wrapper on the straight parts of the coils embedded in the slots. The end turns are insulated with treated cloth tape with a final layer of cambric and mica tape to prevent the spread of fire. The field coils are insulated from the poles with mica and asbestos thoroughly filled with bakelite and compressed under high pressure, with asbestos between turns also compressed under high pressure. This results in a compact field coil which will not distort under operating conditions. Both armature and field coils are insulated with materials that will stand an operating temperature of 150 deg. C.

The tenth unit differs from the preceding ones in that it has a closed ventilating system. Fig. 2 shows the ventilating arrangement of the first machines installed. The air is drawn in through a duct, either from the outside or from the generator room. After passing through the windings and core it is discharged through the generator frame into an enclosure between two floors of the power house. It is then discharged to the roof of the power house through exhaust fans, or if it is desired, the air can be recirculated to heat the generator room. A diaphragm is located across the wheel pit just below the generator coupling for the purpose of keeping the ventilating air clear of the turbine floor.

Fig. 3 shows the ventilating arrangement used on No. 10 unit. It will be noticed that the ventilating system of the new unit is completely closed. The heated air from the generator passes through the air coolers and is then drawn into the bottom of the generator through the ducts provided and recirculated. In order

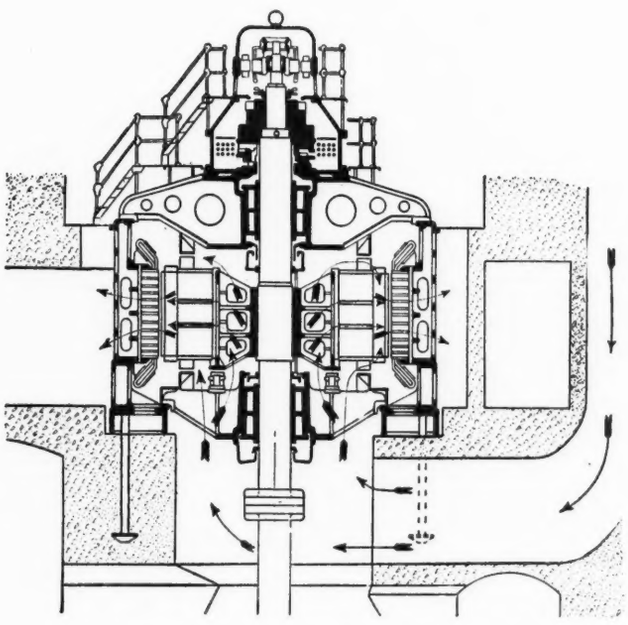


Fig. 2—System of ventilation used on the earlier units

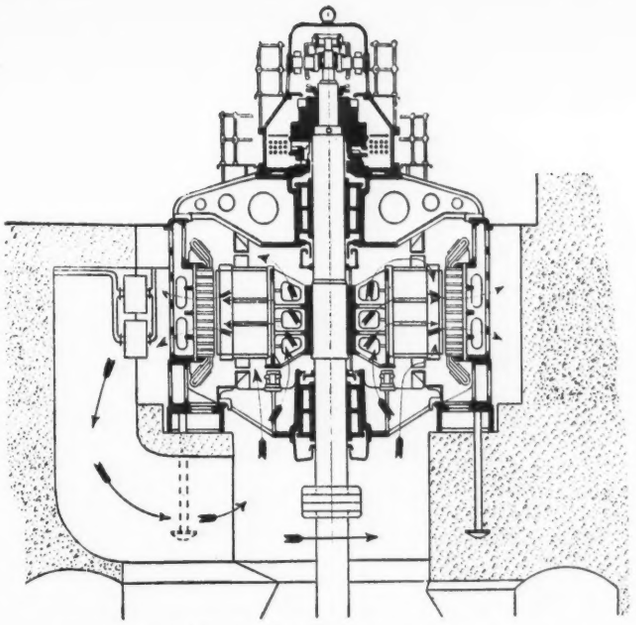


Fig. 3—Closed ventilation system used on Unit No. 10

to make provision for the air coolers, certain minor changes had to be made in the construction of the unit, and, in particular, a new design of blower was required to provide sufficient air pressure. It is hoped that with the new ventilating system it will not be necessary to shut the generators down so frequently for cleaning the windings, and, in the event of fire, carbon-dioxide fire protection is much simplified with the closed ventilating system.

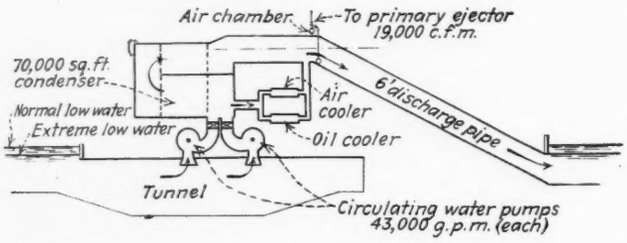
Removing Air Trapped in Condensers

AIR THAT becomes trapped in the water boxes of condensers, decreasing the rate of flow of the circulating water, and, consequently, the rate of heat transfer, is removed most satisfactorily by steam ejector or siphon systems, according to the reports of operating stations submitted to N.E.L.A.

At the Grand Rapids plant of the Consumers Power Company, Jackson, Mich., where considerable trouble necessitated purging the condensers of air, a system was installed which consisted of a one-inch pipe tapped into the top of the water box and carried down to an ejector which discharges into the condenser discharge at a point about ten feet from the condenser outlet. A $\frac{3}{4}$-in. line supplies water for the ejector from the cooling water supply of the condenser. Thus the ejector is operated with an ejection pressure equal to the drop in head through the condenser. The discharge from the ejector is turned downstream through the discharge pipe so that the velocity action in the condenser discharge line is used to aid the injection action.

With the Public Service Electric & Gas Company, Newark, N. J., it is standard practice to install in each station a vacuum priming line which runs the entire length of the turbine room and is common to all main units and station auxiliaries. This system taps into the top of the circulating-water discharge pipes of the condensers, circulating pumps, and other auxiliaries and is

connected to two steam siphons on each unit. In stations carrying most of the system load the priming line is operated with all interconnecting lines open and the steam siphons cut out, relying upon the tail pipe vacuum of the units in operation to overcome any tendency to trap air in the upper water boxes of any of the units standing still. In stand-by stations there is a tendency to lose the water in the idle condensers, and a steam siphon is kept



Water seal prevents air being trapped in condenser water box

in service 24 hr. a day to expedite picking up emergency loads.

To limit the expenditure on circulating-water conduits at the time of the initial installation, the new Atkinson plant of the Georgia Power Company, near Atlanta, Ga., has been designed with individual discharge lines leaving the plant walls at the level of the condenser discharge nozzle and sloping gradually to the river, where the discharge end is carried low enough to effect a water seal at all times. To satisfactorily operate such a system it was deemed advisable to remove the air at the high point of the circulating water discharge line. The arrangement of this equipment is shown in the accompanying illustration.

Of the air removal equipment installations reported to N.E.L.A. since 1928, 89 per cent were steam ejectors, there being no hydraulic air pumps.

Good Progress Being Made on Seven Sisters Falls Development

ONE OF THE largest hydro-electric projects at present under construction in Western Canada is that of the Winnipeg Electric Company at Seven Sisters Falls, on the Winnipeg River, in the Province of Manitoba.

This development will ultimately comprise an installation of six units of 37,500 hp. each, operating under a head of 66 ft. The initial installation will consist of three units operating under a head of about 40 ft., which will later be increased, in two stages, by the construction of dykes inclosing the head pond and by the excavation of the tailrace rock cut. Excellent progress in construction has been made since the beginning of the year, and it is expected to bring the initial installation into operation by July, 1931. Upon completion of this development the Winnipeg Electric Company will abandon its 37,800-hp. plant on the Pinawa channel and the whole flow of the river will be utilized at Seven Sisters Falls.

The Winnipeg is one of the best-known power rivers in Canada. Rising in Lac le Seul, Ontario, it runs for 200 miles and empties into Lake Winnipeg at Traverse Bay. It drains an area of 53,500 square miles, of which 37,900 are in Ontario; 11,000 in the State of Minnesota, and 4,600 in Manitoba. Although the greater part of its drainage lies outside of the Province of Manitoba, its most important reach is notably within that province. It has a fall of 271 ft., of which 230 ft. is capable of development.

Early work on the Seven Sisters project included the clearing of the site, construction of a thirteen-mile standard-gage railroad between the Canadian Pacific Railway main line at Whitemouth and Seven Sisters Falls; the building of a 7½-mile transmission line between the Pinawa power plant and Winnipeg; the erection of a substation for power distribution to the construction work; the building of a camp site for a force of 1,500 men, and the building of a townsite for the permanent staff.

The location of the plant is approximately 65 miles from Winnipeg, and the layout in general comprises a power house and dam built directly across the river which will back up the head water about 50 ft. and submerge the cascades above, forming a large storage reservoir. This rising of the water to a height above the adjacent banks necessitated the construction of dykes extending a distance of approximately four miles on each side of the river upstream above the dam. The dykes are constructed of earth and rock, the latter being excavated from the tailrace. The location of the power house was fixed by the local topography at a point nearly 4,000 ft. upstream from the foot of the last falls, so that it was necessary to excavate a tailrace this full distance to obtain the maximum available head. The dam is provided with sluiceways for discharging the maximum flood flow of the river, and the sluiceways are so located that the spill over the dam will be discharged down the present cascade of the lower falls and thus preserve the beauty of this natural water fall.

Construction view of Seven Sisters Falls

Advantages of Thin Fires and High Induced Draft*

By BERT HOUGHTON
Operating Superintendent, Brooklyn Edison Co.

WE have been taught in the past that to obtain the best results with coal-fired boilers a balanced draft must be maintained in the furnace. This has been practiced and advocated for so long by combustion engineers that it it is difficult to make operators realize that this practice is wrong.*

The fundamental requirement of producing perfect combustion of fuel is bringing the combustible elements in the fuel into intimate contact, molecule for molecule, with oxygen at a correct reaction temperature. This applies not only to coal but to all fuels.

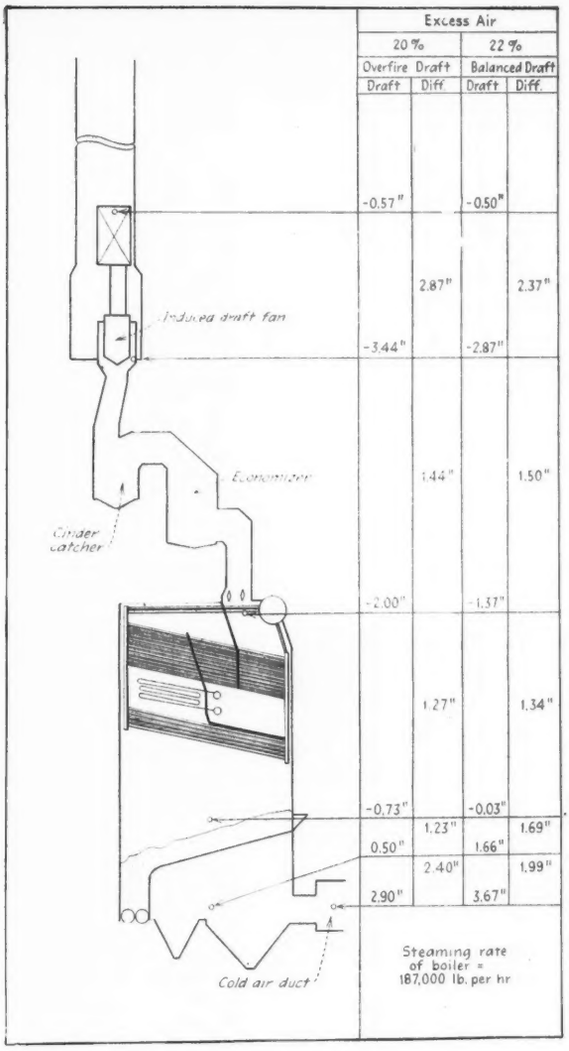
Stoker-fired boilers have been pictured with thick fuel beds, and the greater the demand on the boilers for steam the thicker the fuel bed, thus requiring greater air pressure in the wind box. The air distribution through the fuel bed will not be uniform. Holes will be blown through in spots, causing the coal to fuse and form clinkers instead of coking properly and burning. The results obtained by this practice show a greater waste of fuel due to improper combustion, as shown by higher hydrocarbon loss and increased ashpit loss. Due to greater excess air, the chimney loss will also increase, while the furnace temperature will be lowered.

The sketch illustrates the draft conditions that may be expected from the two methods of firing: One when a heavy fuel bed is used with high wind-box pressure and balanced draft held in the furnace, the other with a thin fuel bed and high induced draft. In comparing the drafts obtained it is apparent that there is a distinct difference in the drops through the fuel bed; the drop when using balanced draft being 37.4 per cent higher than when firing with a high overfire draft. While it has been necessary to increase the induced draft, the forced draft has been more than correspondingly reduced These comparisons, made at the same steaming rate, further show that with high overfire air the excess air can be reduced without the formation of carbon monoxide because of a more uniform air distribution.

In describing the action and results in the first case, I know of no better example than the operation of a blacksmith's forge. High air pressure is brought up in jets under the fuel, causing it to fuse instead of coking and burning. To produce the heat required the blacksmith has to poke and break up the fuel. Otherwise it will and form a clinker instead of burning properly.

In the second case air is sucked through the thin fuel bed instead of being forced through, forming a fine springy fuel bed, the particles of coal being thoroughly mixed with the air at a low velocity.

With underfeed stokers the function of the forced-draft fan is to deliver under the stoker tuyères the weight of air required by the fuel bed. Induced-draft fans acting under control of the steam flow vary the



Draft conditions that may be expected with the two methods of firing

overfire draft, the volume of gas liberated from the fuel bed, and, consequently, the coal feed. With proper adjustment of these conditions the fuel bed will remain thin, even and porous at all times, thereby insuring a uniform and intense rate of combustion. The velocity of a given weight of air through a fuel bed bears a definite relation to the porosity of the bed. The wind-box pressure is also dependent on this same factor. If the fuel bed is tightly packed and hard, an increase in the wind-box pressure under balanced-draft conditions will force holes in the bed. The resultant velocity through the openings will either lift whole sections clear of the grates, with a total loss of air to the remainder of the fuel bed, or it will open up a large number of smaller holes, as in the case of the blacksmith's forge, producing a mass of hard coke and clinker with an uneven heat liberation. On the other hand, with the same tightly packed fuel bed, if the overfire draft is increased to minus .50 in. or minus .75 in., each pore of the fuel bed endeavors to satisfy the vacuum. The coke swells and cracks and air is drawn through myriads of small openings.

It might be expected from this discussion that it is possible to obtain higher steaming rates with this method than with balanced-draft firing. Such is the case. This is particularly noticeable at very high boiler ratings. At such times difficulty is experienced in the ignition of coal

*In view of the probable difference of opinion on the subject, discussion is invited.—EDITOR.

at the head of the stoker. Coal is being introduced so rapidly that it travels several feet down the stoker before kindling. Such a condition materially reduces the effective grate area at a time when every square foot should be 100 per cent effective. Experience shows that by materially increasing the draft over the fire, ignition will start at the front wall. Improved combustion due to improved distribution of air through the fuel bed obviously increases the steaming capacity of the boiler.

It goes without saying that a heavy fuel bed with large openings is not as responsive to an overfire draft as a thin, porous fuel bed. A fuel bed of uniform thickness has almost the same resistance at all points, and this is an ideal condition for the use of high overfire draft. To thicken up a fuel bed in the head or to change its shape in anticipation of load increase will result in thinning out the center section and matting over either the head or tail end of the fire.

Secondary effects that are in reality of major importance resulting from this method of operation are that the boiler tubes, superheater tubes and passes are kept free from fly coal and ash, which, in turn, gives more uniform and high superheat and boiler efficiency. The added cost of building and maintaining the tighter settings and flues is more than offset by the improved economy of operation.

Maintenance of stoker parts, boiler settings and brickwork is appreciably reduced when high suction is used in the combustion space. The gases are cleared more readily and do not separate into stagnant eddies which reduce the effective furnace volume.

To achieve and maintain high rates of combustion per unit of area on an underfeed stoker, a high furnace draft and thin, porous fuel beds are essential characteristics. It may be well to point out how the stoker can aid in obtaining a more porous fuel bed. In the present stoker designs upper, or feed, rams push the coal into the retorts inside the furnace, and auxiliary rams operating nearly parallel to the fuel bed movement push the coal toward the ashpit. This parallel ram action tends to pack the coal, thus interfering with the passage of air.

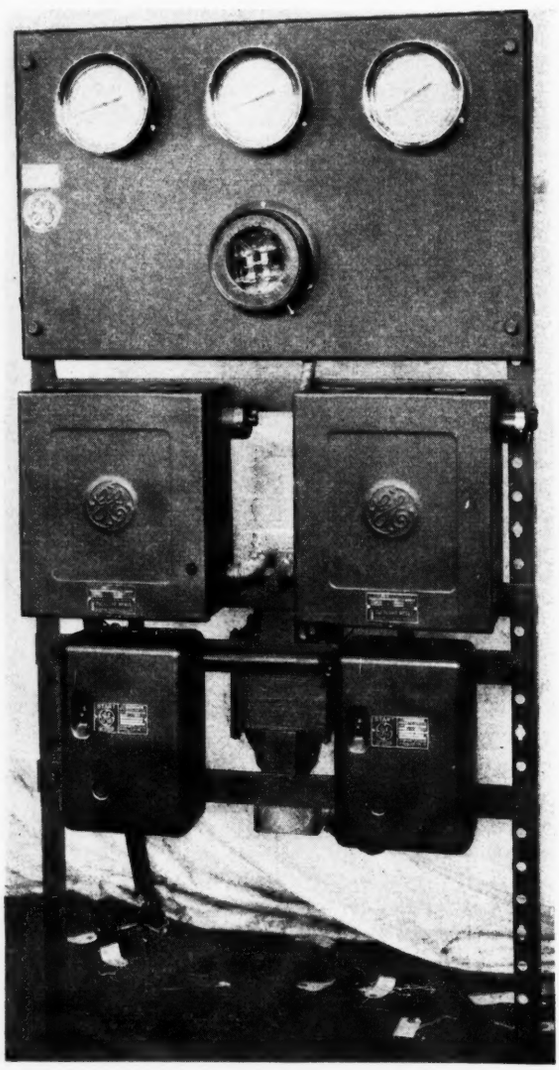
When we fired by hand a slice bar ranked equal in importance with a shovel. The fuel bed was broken up to permit the free passage of air. Likewise, in underfeed stoker design the fuel bed must be given a motion at an angle to its travel so that more openings can be furnished through which the overfire draft may draw air through the fuel bed, thus bringing about a greater intensity of combustion, with a lowered wind-box pressure.

At high rates of combustion, prevention of holes in the fire becomes of increasing importance. Consequently, a great deal of attention must be given to coal hopper designs, so that the feed rams will never fail to deliver the maximum quantity of coal at each stroke. Retorts must be shallow, so that the volatile matter may be completely distilled close to the front wall. Ignition must be carefully watched, particularly with low volatile coals, for as the linear movement of the fuel in the retort increases, ignition must take place at an increasingly rapid rate.

In summing up, it may be said that the operation of drawing the air through the fuel bed, rather than forcing it through, gives a different character of fuel bed, which offers more and smaller openings and consequently gives better mixing of air, coke and gas, and allows the air to pass through the bed with a smaller pressure drop for the same volume.

Co-operation Improves Control Panel Design

THIS CONTROL PANEL is an interesting example of how co-operation improves design from a standpoint of appearance and simplification. The York Ice Machinery Corporation was to install an electric refrigeration control panel, manufactured by the General Electric Company, but three pressure gages and a mercoid pressure switch were to be furnished by the user. Instead of shipping the panel to its destination and mounting the supplementary devices there, they were shipped to the control manufacturer and assembled with the panel. This produced a neat, completely assembled job.



Refrigeration control panel, for two 30-hp. compressors and two 2-hp. brine pumps, for use with mercoid pressure switches

✦

Wrong Mill Illustrated—In our description of the Waldorf Paper Products Company plant in the July 29 number the wrong photograph was inadvertently used to illustrate the 6-ton mill. The photograph shown was that of a smaller mill made by the same manufacturer, the Strong-Scott Mfg. Co., but employed in a different installation. Attention is called to the fact that the two mills were driven by different types of motors.

. . . RIGHT OUT OF THE PLANT . . .

Accuracy Requirements of Multiple V-Belt Drives

NOT INFREQUENTLY in a multiple V-belt drive one or more belts will be noted to sag to a greater degree than adjacent belts. Conclusions are often reached that those particular belts which show the greatest sag are stretching badly. While this may in rare cases be true, the real facts are usually found to be that the sagging belts are a fraction of an inch longer than the other belts and were originally so at the time of installation, or that the V-grooves in the sheaves are incorrectly cut. Then too, the lodging of dirt on the sides of the grooves will produce unevenness in the belts.

Few engineers realize the large sag effect that will be obtained by the addition of a fraction of an inch in the length of a belt. Hence a consideration of this point should prove interesting.

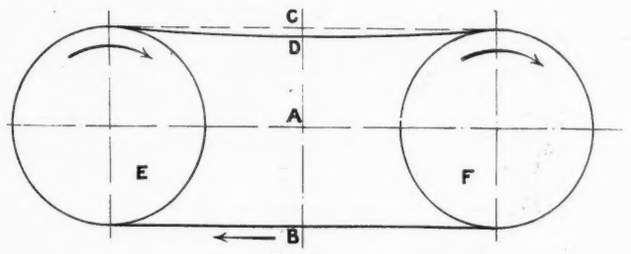


Fig. 1

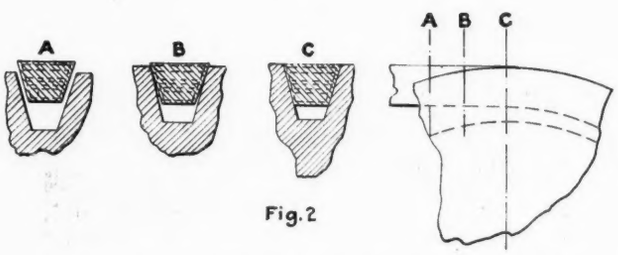


Fig. 2

Typical arrangement of drive and action of a V-belt in its groove

Referring to Fig. 1, we shall assume a driving pulley V-sheave *E* and a driven sheave *F* with a number of V-belts. Points of consideration are (1) Variation in lengths and width of belts, (2) accuracy of the V-sheave grooves.

1. Where there are a number of belts transmitting the load it is desirable, but not of great importance, to have all belts of an exact length. It is true, in general, that with an increasing length of a belt, with a resultant distance of sag *CD*, there will be a greater arc of contact on each sheave and hence a higher degree of power transmission. Considering the fact, however, that V-drives usually are figured for 180 deg. angle of contact, with an efficiency of transmission as high as 98 per cent, there cannot, on a standard drive, be any great advantage in increasing the sag purposely. This sag *CD* may appear to be quite great, yet it is not often considered how small may be the factor which creates such a large sag. For instance, take the question of difference in lengths of belts. In the table a number of different distances between centers are assumed and the difference in length of ½-in. and 1-in. belts are given. The driving side is assumed without sag.

Center Distance Between Sheaves, In.	½-In. DL[1] Approx. Sag, In.	1-In. DL[1] Approx. Sag, In.
10	1.6	2.2
20	2.2	3.2
50	3.5	4.9
100	5.0	7.0

[1]DL designates difference in length between a belt which is taut between two sheaves and one which is increased by the dimension shown.

It becomes apparent that the actual amount of sag increases, for a given difference in length of belts, in proportion to the distances between centers.

Belt stretch, however, is in many cases not the main cause for unequal sags in belts. The greatest trouble is usually found in the sheave itself. Fig. 2 shows the action of a V-belt in its groove. *A* shows the belt entering the groove, at *B* it is seating, and at *C* the sides are in tight contact with the sides of the groove. The load is picked up gradually as the belt seats itself and naturally exerts a shock-absorbing effect, independent of the elasticity of the belt itself. This is the ideal condition. If all grooves are cut correctly and are polished this action will take place simultaneously in each belt of the drive.

Assume, however, that (1) angle of one or both sides of groove are incorrect, (2) rust or foreign material has deposited on one or both sides of the groove, (3) sides of groove are roughly machined.

Any one of these factors will make the belt ride high in the groove and thereby tend to increase the length of that particular belt. The other belts will then have the appearance of sagging. Furthermore, one high spot on the side of the groove would cause an up-and-down slap of that belt. Under such conditions the sides of the belt would not engage properly against the sides of the groove.

A belt that actually stretches badly under load conditions is not desirable. Yet a V-belt drive, with accurate grooves, will function properly even though belts are of unequal length. The sheaves, however, must be accurate.

Philadelphia, Pa. R. E. S. GEARE.

Maintaining Service in Coal and Ash Handling

IN CONNECTION with the article entitled "Maintaining Service in Coal and Ash Handling" which appeared in the Aug. 26 number, the last paragraph of which refers to the sluicing of ashes, the first sentence states that in large plants where water is plentiful ash sluicing has become common. This is a rather limiting sentence, for quite a number of plants recirculate the water used for ash disposal. The water passes through screens and is used over and over again for the removal of ashes. This arrangement is used at the Atwater Kent Manufacturing Company, Pennsylvania Railroad's West Philadelphia heating plant, and the Celanese plant in Cumberland, Md. Furthermore, the use of the "Hydrojet" is not confined to large plants alone, for there are quite a few installations in plants of about 1,000 horsepower.

The second sentence of the last paragraph states that the replacement of ash pump impellers is the largest item under maintenance expense. This is not true in installations where the ashes are sluiced into a sump and then removed by a clamshell or sluiced for filling in lowlands adjacent to the power plant. In these cases the ashes are removed by clear water and the material does not enter the pump. In installations where the ashes are pumped from the sump into an overhead storage tank or are pumped a considerable distance from the plant for filling in lowlands, there is a certain amount of wear on the impellers. This is because the abrasive ash passes through the pump. However, since many plants handle ash without passing it through a pump, it is hardly fair to give the impression that in the sluicing of ashes there is considerable wear on the pump.

Philadelphia, Pa. EUGENE A. HOLLAND.

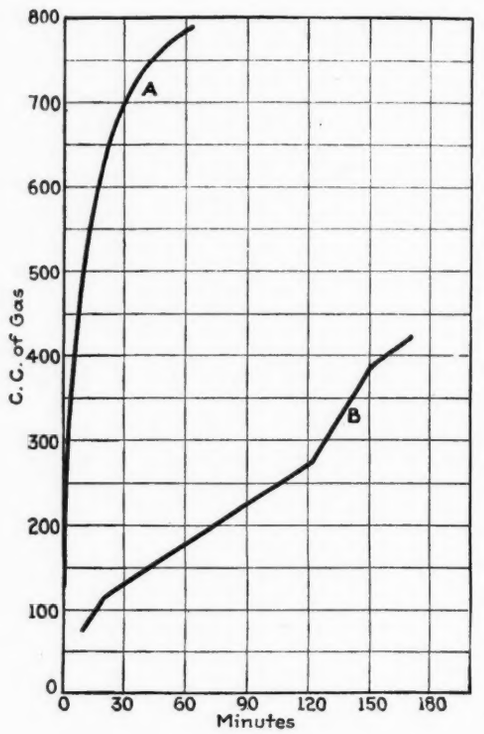
Gas Produced in an Electric Steam Generator

THE ARTICLE entitled "Gas Produced in an Electric Steam Generator," by Ariel W. Miller, in the July 8 number, was of special interest to me inasmuch as I have made a trip through Canada where a large number of these generators are used and have discussed this subject with a number of operators.

It seems to be generally accepted that there is some generation of hydrogen in an electrode boiler, and tests I saw showed that the hydrogen content of steam from an electric boiler was, roughly, three times that found in steam from a typical coal-fired boiler for industrial service. Another thing, I understood that the generation of hydrogen was proportional to the ampere input; whereas Mr. Miller says that the amount of gas varies inversely as the amount of steam used.

I wonder if the tests that he mentions were not made immediately after the boiler was put in service, while the boiler and piping were still filled with an excessive amount of gas. The tests were then continued as the boiler was gradually brought up to load. Naturally, the amount of gas evolved would decrease as the length of service was increased, due to the excessive amount present at first. And as the steam generation gradually increased the gas evolved would appear to decrease; whereas it would actually show an increase if the gas present initially were not considered.

As an example, I have the test data shown by the curves in the illustration. Curve *A* refers to a test started at the time the generator came to the normal operating pressure of 100 lb. gage. The test ran 62 min. and showed a considerable decrease of gas generation after the boiler had been in service for a few minutes. During this period 790 c.c. of gas was trapped out of 5,010 c.c. of condensate, and this gas was 1.3 per cent (10.27 c.c.) hydrogen and 18 per cent oxygen. This amounted to 0.00205 cu.ft. of hydrogen for each cubic foot of water evaporated, or 0.157 cu.ft. per hour with



Curves show cubic centimeters of gas produced by generator at time of going into service, and also over a three-hour period

a power input of 1,450 kw. on a 5,000-kw. steam generator. On another basis this was 0.00131 cu.ft. of hydrogen per ampere per hour.

As shown by *B*, the gas evolution decreased after the generator was in service several hours, because the volume of air trapped in the shell and piping passed out with the steam during the first hour. During the second test, of 2 hr. 43 min., 407 c.c. of gas was trapped out of 21,993 c.c. of condensate. It was 4.4 per cent hydrogen (17,908 c.c.) and 20.5 per cent oxygen. This amounted to 0.000815 cu.ft. per cubic foot of water evaporated, or 0.05688 cu.ft. per hour with a power input of 1,310 kw. This is equivalent to 0.000527 cu.ft. per ampere per hour.

Taken roughly, the hydrogen content during the first hour after starting was three times the content after several hours of operation. This was a 6,600-volt generator, and the feed-water temperature was kept at about 180 deg. F. Gas was collected in much the same manner as described by Mr. Miller, but the samples were taken

from a ½-in. steam line connected to the upper side of the steam main so as to obtain as nearly as possible a homogenous mixture.

General conclusions of these tests were that if the generator supplied steam to a system where the condensate returned to an open hotwell, where some deaëration took place, there was no danger of having an accumulation of hydrogen, but if the steam were in a completely closed system, evaporating the water over and over, an accumulation might take place which could possibly be ignited by an arc drawn from the electrodes.

As a matter of interest, some experiments were made with steam generated in a coal-fired boiler. Using the same apparatus, 160 c.c. of gas was collected from 50,000 c.c. of condensate, showing 10 per cent hydrogen was formed by the action of water, or steam rather, in contact with the hot iron. This was at the rate of 0.0003 cu.ft. of hydrogen per cubic foot of water evaporated, or about 37.5 per cent of that produced by the electric boiler during constant operation.

From curve *B* it is evident that as long as conditions in the generator are constant the gas evolution is constant. After two hours the feed water regulator admitted more water to the lower compartment, and the gas evolution increased due to the dissolved air. When this air was removed the rate of evolution dropped back to where it was before, as shown by the same slope on the curve. The density of the water will vary with the temperature, being less at higher temperatures. Also, dissolved gases will be less the higher the temperature, so that we might expect the gas evolution to increase as some inverse function of the density, as Mr. Miller says. But it does not seem that his conclusions check so well with the tests referred to in the foregoing when the power output relation is discussed.

Considering that his company has apparently made a rather extensive study of the problem, that there is little information available and that it is a subject of vital interest to a great many men and companies, I wonder if it would not be possible for him to get some further data giving the results and conditions of the tests and amplify the conclusions. P. F. ROGERS.

Brooklyn, N. Y.

Attaching Leather Lagging to a Small Pulley

IN THE Sept. 9 number a method of attaching leather lagging to a small pulley is illustrated and described. There are several methods of increasing the power-carrying capacity of small pulleys in addition to that of lagging.

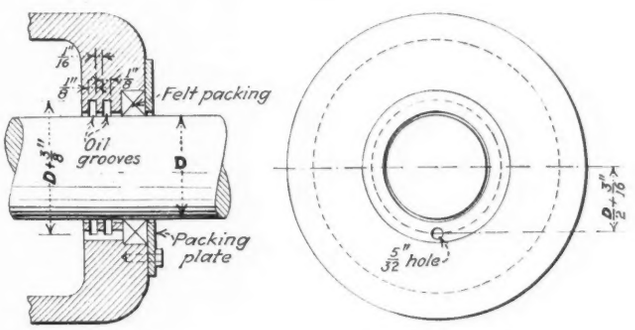
In the case of high-speed wood-working machinery the usual practice is to cut a right- and left-hand spiral groove on the face of the pulley to release the air between the pulley and belt. Another method is to cut a left-hand helix from the center of the pulley to the edge on one side and a groove with a right-hand pitch on the other half of the pulley face. Both methods are used for the same purpose, that is to release the air.

There is another method, that of drilling small holes in the pulley rim. Where the pulley is solid it is advisable to drill a series of ⅛-in. pipe tap holes over the surface of the pulley. The holes may be reamed taper (pipe tap reamer) or tapped and plugged with small corks, a little shellac being used to cement the plugs in place. The corks may pass through a thin pulley rim or bottom in a hole. Where balance is important the holes should be carefully spaced and be of equal depth. The corks should be cut off so that they project about $\frac{1}{32}$ to $\frac{1}{16}$ in. above the surface. This method is simple, increases the frictional resistance and relieves the air. It will be found to be highly satisfactory and at a cost that is reasonably low as it can be done with a portable drill with the pulley in place on the machine. JAMES MCINTOSH.

Cleveland Heights, Ohio.

Oil Grooves in Bearing Housings Stop Oil Leakage

SOME TIME AGO several methods were shown in *Power* for applying felt rings to bearing housings to prevent oil from leaking out around the shaft and to keep dirt out. We have tried felt rings to stop oil leakage, but found that after a short time they did not function properly. This was due, possibly, to ring wear or to a change in the composition of the felt by the



Location of oil grooves cut in bearing housing around the shaft

action of the oil. Frequent renewal of the felt rings would remedy the trouble of oil leakage, but this became a nuisance.

After experimenting, it was found that oil grooves cut in the bearing housing around the shaft was a permanent way to stop oil leakage. The figure shows how these grooves are cut. The grooves are ⅛ in. wide and about $\frac{3}{16}$ in. deep. If the diameter of the shaft is *D*, the grooves are cut to a diameter of $D + \frac{3}{8}$ in. There should be at least two oil grooves. A $\frac{5}{32}$-in. hole should be drilled in the housing as shown in the figure. The oil that is carried along the shaft is thrown off into the grooves by centrifugal force. As the oil accumulates in the grooves it flows to the bottom by gravity and runs back into the bearing through the hole. The walls between the grooves need be only $\frac{1}{16}$ in. thick. In case there is not sufficient stock in the housing to allow for the cutting of oil grooves, it is recommended that the housing be rebored to take a bushing. This bushing can be made sufficiently long for the oil grooves.

Tests have shown that with oil grooves no oil leaks out along the shaft even when felt packing is not used. However, felt packing and packing plates are used to keep dust and dirt out of the bearings.

Worcester, Mass. DAVID FLIEGELMAN.

From Among Readers' Problems

Conducted by
L. H. MORRISON

EXHAUST PIPE SIZES—*What sizes of exhaust pipes should be provided for engines of 150, 500 and 650 kw. capacity, and what should be the size of a common exhaust main from three engines?* P. F. R.

The size of exhaust pipes for each engine should be the full size of the exhaust connection provided by the builder of the engine. When the sizes must be decided upon in advance of this information, the exhaust branches should be at least 7 in. for an engine of 150 kw. capacity, 12 in. for 500 kw. and 13 in. for 650 kw. capacity. Ordinarily, the sizes provided in the engine connections may be continued for the full lengths of the pipes without material increase of the back pressure.

Where two or more engines exhaust into a common main it is the usual practice to provide a main whose cross-sectional area is equal to the combined areas of the branches. This, however, results in greater carrying capacity or less back pressure than if the mains were carried side by side for the same distance, since the capacities of pipes of the same length and the same drop in pressure are as the square roots of the fifth power of their diameters. Hence for the same back pressure from a single main, as from branches 7, 12, and 13 in. in diameter, and for the same length, the main could be about 16 in. in diameter.

SHORTEST CUTOFF FOR THROTTLE-GOVERNED SLIDE-VALVE ENGINE—*What is the shortest cutoff we can get with a throttle-governed slide-valve engine, and what changes have to be made in the valve setting?* P. H.

Under favorable proportions of inside and outside lap and valve travel the shortest cutoff practicable for a throttle-governed slide-valve engine is one-half to five-eighths of the stroke. Earlier cutoff results in port opening so slow and insufficient as to cause wire-drawing that will admit much less than the steam-chest pressure to the cylinder, even in the beginning of the stroke, and the excessive compression obtained is also objectionable for this type of engine.

To obtain earlier cutoff with a given valve and eccentric, first lengthen or shorten the eccentric rod or the valve stem to obtain the same amount of valve travel each side of the admission edges of the steam ports for a complete revolution of the crankshaft or complete revolution of the eccentric around the shaft. Then from either dead-center position, place the crosshead at the fraction of stroke desired for cutting off and set the eccentric forward on the shaft to a point where the admission edge of the valve just closes the port of that end of the cylinder from which steam should be just cut off.

For an ordinary D slide valve with outside admission which has the valve stem connected to receive its motion in the same direction as the eccentric rod the eccentric should be more than 90 deg. and less than 180 deg. ahead of the crank. But where a rocker is used for driving the valve rod in a direction reverse to the motion of the eccentric rod, or for the same direction with a valve having inside admission, the eccentric should be less than 90 deg. behind the crank. Where there is both a reversing rocker and valve with inside admission, the eccentric should be between 90 and 180 deg. ahead of the crank.

BALANCED DRAFT—*What is meant by operation of a boiler with balanced draft?* B. D. A.

The term balanced draft is generally applied when the draft pressure above the fire resulting from a forced-draft air supply is equal or very slightly in excess of the pressure of the atmosphere. When this draft condition exists, heated gases of the furnace are not lost by being forced out through the fire door or crevices in the boiler setting. Because with balanced draft in the furnace the required force of draft in the boiler uptake is no greater than necessary for overcoming the draft losses between the furnace and stack damper, infiltration of air through openings or crevices in the boiler setting, with resulting loss of economy, is reduced to a minimum.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

OUR plant, containing two 4,250-sq.ft. 300-lb. boilers, is now served by one centrifugal boiler feed pump. We feel that a stand-by should be provided. Should this be a centrifugal, a steam-driven duplex or an injector? C.A.R.

FOR steam-generating capacities of boilers the size stated, where we may assume that each boiler can produce 10,000 to 60,000 lb. of steam per hour, it is perhaps a matter of choice whether a centrifugal or reciprocating stand-by pump is used. An injector deserves no consideration for the installation under discussion.

Electric- and steam-turbine-driven boiler-feed pumps are both used in high-pressure plants, the determination of which is used depending largely on what the heat-balance system and auxiliary power supply comprise. The electric drive has the advantage of simplicity so far as the motor is concerned. The maintenance of the motor will be less than that for a steam turbine. The reliability of the motor is about the same as that of the small turbine, but the reliability of electric drive hinges more largely on the dependability of the power supply.

It is of importance to note that in practically all cases where electric drive is used for boiler feed, the auxiliary power system supplying the boiler feed pump motors and other major auxiliaries is substantially independent of the main power supply, so that main line disturbances, such as short circuits, do not interfere with the major auxiliaries. This is accomplished either by a separate house-turbine or house-generator and more or less complete segregation of auxiliary power circuits from main

circuits. In the few cases where auxiliary power is taken direct from main power lines, the boiler feed pumps are provided with dual drive or separate power lines from a neighboring plant, or else complete steam-driven spare units. Another difficulty with all-electric drive is the impossibility of starting up for the first time, or after a complete shutdown, without an outside source of power.

Since it is not stated that this plant has a separate auxiliary power supply, and possibly no outside power, a steam-driven centrifugal or piston pump is clearly indicated from the point of reliability and starting up.

F. W. RABE, *M.E.*,
Anheuser-Busch, Inc.
St. Louis, Mo.

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FOR a cheap installation and economical operation I should install an injector as a stand-by. For a reliable and efficient installation I should use a turbine and motor-driven centrifugal pump. If for any reason the steam supply to the pump should fail one could operate the pump with the electric motor. With this type of pump the plant is prepared for almost any emergency. WILLIAM DEELEY.
Orange, N. J.

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THE QUESTION cannot be answered definitely without having additional information as to the type of plant and conditions of operation. If the plant must be kept in continuous operation, with the possibilities of interruption reduced to a minimum, good practice indicates a second centrifugal pump identical with the first. This would enable the operators to run each pump approximately one-half of the time, and there would be no reason why both pumps could not be maintained in first-class condition.

The injector is simple and cheap. It will not operate satisfactorily, however, with feed water much over 100 deg. Its efficiency as a pump is very low, most of the heat of the steam supplied to it going to heat the water. If a cheaper source of heat than live steam is available for feed-water heating, the use of an injector will not be economical.

The steam-driven duplex pump is widely used for boiler feeding in smaller plants. Its first cost is not excessive and if given a reasonable amount of care and attention it will give good, reliable service. The steam consumption of a duplex pump is from five to ten times that of a steam engine of equal power, but if its exhaust can be utilized for heating the feed water, that does not result in a very great loss.

If the plant in question is generating electric power and adequate means are already provided for heating the feed water, an additional motor-driven centrifugal feed pump will prove the most economical from the standpoint of power consumption. P. A. WILLIS.
Washington, D. C.

TWO means of feeding boilers should always be provided in every steam generating plant; in fact the laws governing the operation of steam boilers, in many states makes this mandatory.

The choice of a suitable spare boiler-feed pump rests upon several conditions, namely: (*a*) Does a source of water supply exist at all times, and if so, at what suction head or lift; (*b*) at what temperature is the supply water available; (*c*) how much money is available, to be spent on a pump.

Assuming that the water supply is available at a temperature of 212 deg. F. from a feed water heater and also from another source under a head pressure at an average temperature of 68 deg. F., then a steam-driven turbine centrifugal pump having the same characteristics as the one installed will make an ideal spare, although much more expensive than a duplex steam pump.

A duplex steam pump will adequately provide a spare method of feeding the boilers is comparatively inexpensive, can lift water without priming and can handle comparatively hot water, under lesser suction heads than the centrifugal type.

Hence, as a spare feed pump the steam-driven duplex appeals.

An injector, while fairly reliable in action if frequently used, is not recommended, because its rate of feeding is extremely limited. It will not feed hot water, that is, water coming from a feed water heater. On the other hand, it is the cheapest and most efficient method of feeding cold water into a steam boiler. It is commonly used in the smaller boiler plants.

Bayonne, N. J. E. A. BAERER.

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A CENTRIFUGAL pump, steam turbine driven, will have a slightly higher efficiency than a duplex steam pump, will take up less floor space and will not require a stock of repair parts all to itself. Repair parts for the present pump will serve the new one.

At the boiler pressure mentioned the injector would work only on feed water which is just about cold, and this would cut down the boiler output considerably, if the feed water is now preheated.

If it should happen that the motor burned out while the turbine-driven pump was under repairs, the pump from the motor-driven unit could be switched over in a short time.

R. A. DICKSON.
Caldwell, N. J.

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BY ALL MEANS a stand-by pump should be provided. In fact, it may be interesting to know that the boiler code in the city of Cleveland requires two means of feeding for boilers of 500 sq.ft. heating surface or more, an injector being permitted for stand-by, with a pump as the regular means.

It would seem that another centrifugal pump of the same size and make would be preferable as a stand-by, thereby keeping the quantity of spare parts down to a minimum and permitting of interchangeability.

From the standpoint of initial cost, the centrifugal unit will be less expensive than the steam-driven duplex. Maintenance will be less and requisite floor space will be less.

An injector requires no floor space and practically no maintenance, but requires the attention of a good operator. Its selection should be guided by the type of personnel available at the plant in question.

Should any major repairs be required on the present centrifugal pump, the stand-by period would possibly be too long to be properly handled by an injector.

Consequently, it would appear advisable to select a stand-by pump identical to the present one, that is, a centrifugal. A. D. SNYDER.
Cleveland, Ohio.

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ASSUMING that the present centrifugal boiler feed pump is electrically driven, it would be most practical to duplicate this equipment for a stand-by unit. The care and upkeep for both pumps would be the same, and to keep them both in first-class condition the pumps should be operated alternately. This would tend to equalize the wear on the machines. Occasional use is much better for a machine than to have it standing idle continuously.

If there is a possibility of the electric current's being interrupted, it would be advisable to select a steam-driven feed pump, either centrifugal or duplex. The duplex would be preferable because of simplicity in care and operation, and because of the size of the installation.

The installation of an injector for stand-by service would be desirable only where the consideration of low initial cost would be of utmost importance. If the operating conditions are not severe and the need of a stand-by pump is not urgent, then it would be economy to install an injector to be used for emergency purposes only.

J. M. HARTMAN.
Kewanee, Ill.

A Question for Our Readers

CERTAIN brass parts about our water system become spongy. An architect has recommended that in our new plant brass pipe be used in our water system. Is this advisable along the sea coast?

C.M.

Suitable answers from readers will be paid for and published in the Nov. 4 number.

Influence of Nitrogen in Air Supply On Combustion in Gas Engines

By ROBERTSON MATTHEWS

THE NITROGEN in the air-supply to an engine is commonly accepted as is water added to high-grade milk—something difficult to eliminate, yet undesirable because so much more air volume must be consumed in order to obtain a given benefit.

In large engines the nitrogen acts as flywheel on temperatures. It keeps the temperature from periodically, with each cycle, going too high. But in small cylinders, where capacity is usually a vital item, it is not essential that the maximum allowable temperatures be as limited as in large cylinders—hence nitrogen has less to commend it for small engines. And when it comes to one type of engine being handicapped in competition with another type because of greater excess air requirements, the supposedly neutral nitrogen appears to be simply a drag on attainable capacity.

Some recent experiments, however, with gases in bombs, show conclusively that nitrogen under some conditions is not a neutral constituent during combustion. With initial pressures upward from 50 lb. per sq.in., nitrogen creates an increasing drag on the rate of combustion and on the cooling of the products of combustion. The influence apparently is not simply a change of temperature rise, such as would occur from increasing the weight of gases without a proportional increase in heat produced.

It has been definitely settled that in CO-air mixtures it is not, as supposed heretofore, an inherent property of CO that causes it to burn slower than hydrogen. That free carbon is slow to burn, is well exemplified by the use of carbon and graphite as electrodes in arc lights. Of these two forms of carbon, the graphite burns the slower, but both forms burn too slowly to be desirable constituents of a combustion reaction in engines supposed to use gaseous and liquid fuels only. Hence the wisdom of our knowing all that is to be found regarding the combustion of hydrocarbons, and of preventing the throwing out of free carbon during a combustion process.

Such behavior of free carbon may have suggested a reason for the apparently slower burning of CO in CO-air mixtures than hydrogen in hydrogen-air mixtures. Formerly it was held that the hydrogen in fuel burns first and the carbon takes such oxygen as remains, but combustion of hydrocarbons is not now considered so simple a process.

As regards the supposedly slow burning of CO, research shows that a mixture of CO and oxygen burns almost instantaneously, provided at least a small amount of hydrogen, or steam, is present. The hydrogen need not exceed one per cent in order to make its accelerating influence effective. But as soon as nitrogen is added, slowing up of combustion occurs, which does not occur if CO is substituted for the nitrogen. Bone, Newitt and Townend, in the volume reporting their careful experiments, speak of nitrogen as becoming activated during the early part of combustion and later giving back as heat the energy that caused this activation. Consequently the maximum pressure is attained later when nitrogen is present, though the attained maximum pressure may not be appreciably diminished as a consequence of this activation. The cooling of the gases in a bomb is also delayed.

In this day, when there is advocacy of reducing the capital cost of engines by building them for higher speeds, it may be worth while to consider any possible benefits or detriments to engine operation from the combustion lag arising because of the presence of nitrogen, and particularly in those engines for which it seems necessary to supply considerable excess air. Such a consideration might be divided between combustion conditions and ignition provisions.

As, however, with literally heaps of our data on fuels and their behavior, the experiments of the data just referred to have been carried out under conditions which make it uncertain as to just how far the data is applicable to engine operation. Engine operation in comparison with experimental bomb operation, would provide an amount of turbulence not found in a bomb unless a fan were placed in it, and it is known

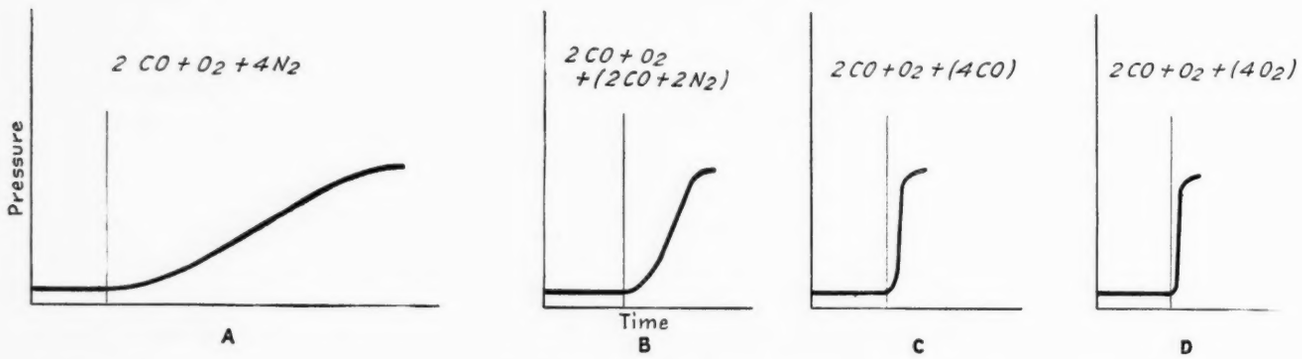
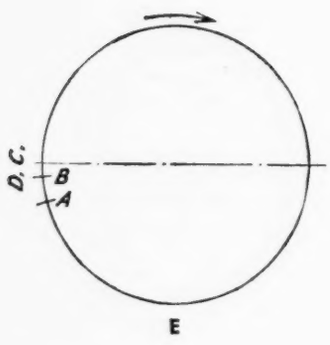


Fig. 1—Effects of nitrogen, oxygen and excess carbon monoxide upon engine combustion, showing variation in pressure rise with time



that turbulence creates effects that are not all included in the mere item of stirring fuel and oxygen together. Also there would be not only nitrogen in the trapped exhaust gases but there would be a proportion of carbon dioxide.

The complete significance of the combined conduct of the carbon dioxide and the nitrogen might not be appreciable, but we do not know. We have apparently not yet had the possibilities or the improbabilities disclosed by experiments. Moreover, the ignition in the tests referred to, was not from heat of compression but from an electrically fused piece of foil. Hence ignition might have some peculiarly directed impetus due to combined electric and heat phenomena that might not be present solely with compression-heated air. There is the further highly significant item of combustion environment, the condition of cylinder walls and suspended media.

The Practical Significance

The limitations of the data might suggest that such experiments are of doubtful value for engine development. But the fact is that the value of such data to the engineer is weakened not so much by the methods of obtaining it as by the inability of the engineer to verify the occurrence of such conditions in his engine cylinders. The primary cause of this situation is the backwardness of finance in giving sufficient encouragement to the invention and creation of instruments. The result for industry of this lack of incentive is about the same as for one who thinks the installation of an excellent pump at the top of a well will meet his ends without his providing inducement for flow into the well.

With high-speed operation, probably the most common difficulty is to obtain high capacity together with high fuel economy without high maximum pressures. It would seem, then, that a further speeding up of combustion may not be desirable; Fig. 1 shows the rate of pressure rise during the combustion of CO under pressure and with different gaseous dilutents. The initial pressure is about 750 lb. per sq.in. absolute.

Rapidity of Combustion

This pressure is higher than engine compression pressures, but it does not exceed the pressures that occur before combustion is completed in many high-speed oil engines. The combustion rate with oxygen substituted for nitrogen would seem to support the shop story of what happened to a cylinder head when a starting bottle was used that had once held some straight oxygen.

But would not a deduction that the combustion lag from nitrogen in high-speed engines is fortunate, be far too simple and incomplete? The path of combustion is tortuous. In this respect its final speed deceives us. That the presence of nitrogen makes the combustion of CO decidedly slow compared with other diluents is depicted in Fig. 1. Here our fuel is about 85 per cent carbon which means the presence of lots of CO. And we want good fuel economy.

In order to overcome such late burning, fuel injection must begin early, say at *A* in Fig. 1E. Probably so early that if there is not constant speed operation, some compression may occur after ignition begins, and then what about maximum pressures? What limit may this early injection place upon overload capacity?

If combustion, or perhaps we should said inflammation, could get under way more rapidly, might not fuel injection begin nearer to dead center, say at *B* in Fig. 1E. This would help to avoid approaches to pre-ignition during variation in engine speed and high-load temperatures, without having, as a safeguard, to inject so late as to encourage late burning.

Attempts to increase the rapidity of combustion might seem to be only another way of inviting the results of attempting to use a fuel having the characteristics of detonative combustion. But there is a difference. There is a wide margin from which to choose between the slope of the combustion curve of Fig. 1A and of 1D. Moreover complete elimination of nitrogen is at present not a possibility.

Result if Nitrogen Were Absent

From those curves it can be deduced that reduction in the amount of excess air does more than increase capacity by making more combustion possible. The absence of nitrogen makes earlier combustion possible, and therefore better fuel economy because of using heat through a longer temperature head. Heat generated at 10 per cent stroke is more useful than that generated at 20 per cent stroke. The absence of nitrogen makes the lag of inflammation shorter after the nucleus of ignition gets started. This points to opportunity of greater precision in timing ignition with respect to dead center, and hence of maximum pressure control.

Decrease in the necessary per cent of excess air is receiving attention through attempts to improve fuel atomization and mixing. Can the proportion, about four to one, of nitrogen to oxygen in that air and in all of the necessary air be improved? There has been talk of something cheap being possible in that direction. It may seem irrelevant. But have we not gas-driven superchargers? Are the intricacies of manufacturing pre-combustion chambers costless? Have we not here and there rather elaborate starting systems?

It may yet be worth while to ponder that at the pressures existing in internal-combustion engines, nitrogen is not a neutral substance, not simply a filler, not simply a conveyor for oxygen. It is a drag on the rate of inflammation and combustion because of some phenomena peculiar to itself. It can decrease not only the engine capacity but its efficiency also.

Commission Reports Further on Interstate Power

NOW practically complete, the Federal Trade Commission's final report on the interstate movement of power will be submitted to the Senate early in December. Another interim report just made public in response to the Couzens resolution places the export of electric energy across state lines in 1929 at 14,505,190,623 kw.-hr. Imports amounted to 15,906,132,127 kw.-hr., the difference being entirely accounted for by imports from Canada and Mexico.

On the basis of these figures the ratio of exports to electricity generated was 15.31 per cent, while the ratio of imports to electricity consumed last year was 19.65 per cent. After deducting duplications from both exports and imports where some quantities crossed state boundaries twice, the ratio of exports to total generated becomes 13.54 per cent and of imports to total consumed 17.57 per cent. The duplication in exports amounted to 1,680,746,671 kw.-hr. and in imports 1,680,633,431 kw.-hr., the difference being due to a slight duplication at the Canadian boundary.

The total electric energy generated and available for public use in 1929, as compiled by the Commission, amounted to 94,703,518,935 kw.-hr. This total includes company use by central stations. The total consumption is reported as 80,955,774,769 kw.-hr., after excluding quantities reported to be lost and unaccounted for and of estimated quantities belonging in this category for companies not reporting such figures.

The Commission's final report will present quantities and ratios for individual states in some detail. A rough draft of the Commission's report was completed on August 20, the day that the Commission's offices were severely damaged by fire. The text was not destroyed, however.

All Available Wilson Dam Power Being Utilized

ALL OF the energy available in the Tennesseee River at its present stage is being developed at the Wilson Dam. In July 58,302,000 kw.-hr. was produced. Final figures for August are not yet available, but the total will be slightly less. Even with the entire flow of the river being utilized the Alabama Power Company is securing only 20 per cent of its requirements from Muscle Shoals.

More power was used in July and August than during the entire first six months of the year. From Jan. 1 to June 30 sales of Muscle Shoals power totaled 104,997,900 kw.-hr. In the calendar year of 1929 total sales were 171,681,000 kw.-hr. Maximum production in the history of the operation was in August, 1926, when 65,000,000 kw.-hr. was sold.

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

New Principle of Cooling for Motors

THE MOSSAY principle of cooling is used in a new line of fully inclosed fan-cooled induction motors in sizes from 20 to 150 hp. put out by the Reliance Electric & Engineering Company, 1042 Ivanhoe Road, Cleveland, Ohio.

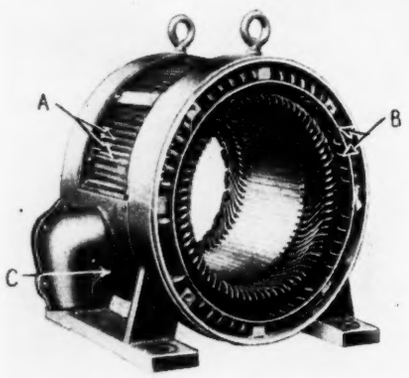
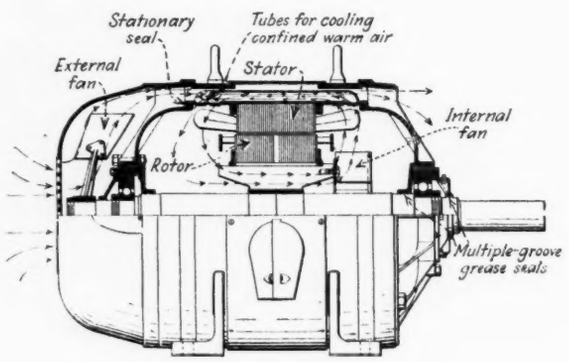


Fig. 1—Motor stator with mossay principle of air cooling

This method of cooling is employed for these larger sizes because the design of the smaller motors does not provide sufficient cooling area. The extra cooling surface is obtained by use of tubes extending over the outside of the stator, as shown at *A* in Fig. 1. The tubes are welded into openings in a header, as indicated at *B*.

Referring to Fig. 2, a single internal fan on the rotor circulates the confined warm air through the tubes, over which are blown blasts of cool outside air from one end of the motor to the other, as indicated by the arrows. The stator enclosing band *C* (Fig. 1), which prevents the escape of the cooling air, is readily removed for cleaning of the tubes. With this method it is possible even in the larger sizes to build inclosed fan-cooled motors that are interchangeable in mounting dimensions with standard open motors of the same horsepower and speed rating.

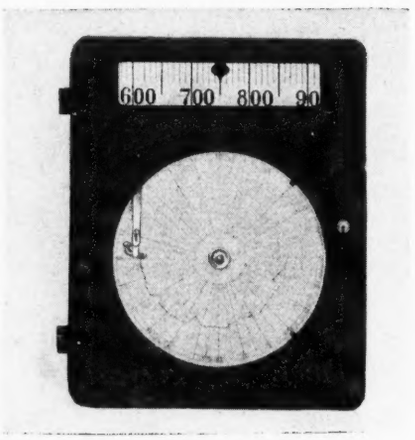
The stator windings and rotor are tightly inclosed. The fits for all inclosing parts are machined surfaces. All seals are stationary. In dismantling, the only extra parts to remove in addition to those of the standard open motor are the external, fan guard and fan.



Partial cross section through motor, flows of confined and outside cooling air indicated by arrows

"Self-Contact" Potentiometer Pyrometer

IN THE "self-contact" potentiometer pyrometer recently developed by the Uehling Instrument Company, 26 Vesper St., Paterson, N. J., depressor bars, cam mechanisms and continuously operating motors have been eliminated. This has been made possible through a special method of making definite and reliable contact between the needle of a galvanometer and stationary contact pieces.



Indicating and recording pyrometer

The new recorder retains all the advantage of the potentiometer, and improved contact method permits placing the galvanometer apart, and at almost any distance from the recorder. This makes possible a simple and rugged recorder construction that will withstand rough usage. A single galvanometer will actuate as many as four recorders in different locations, each measuring a different temperature, and, if desired, each having a different calibration.

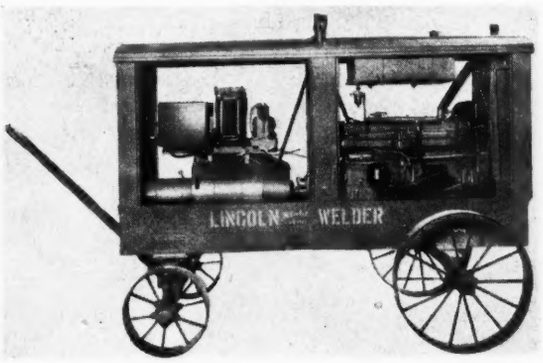
The entire recording mechanism is fastened to a frame hinged to the case. This gives accessibility to all parts of the apparatus. A small motor operates only as and when necessary to adjust the pen to the proper temperature reading on a clock-driven chart. It is also in geared connection with two pulleys over which a translucent endless belt, about 2 ft. long, is placed. The belt is calibrated in temperature units and will move in direct proportion to the pen mechanism, but at a greater speed. This permits of an open and legible scale. The legibility of the figures, the exceptional length of the scale, and the fact that it is illu-

minated from the rear, make it easily read at a distance of 75 ft. or more. Either a thermocouple or an electric resistance bulb may be used as the temperature element.

High Capacity Gas-Engine-Driven Welder

GROWING use of larger-sized electrodes has led to the development of larger arc-welding machines designed especially for field work. In the unit illustrated, recently brought out by the Lincoln Electric Company, Cleveland, Ohio, the generator is rated at 400 amp., with a current range up to 500 amp., and is of the variable-voltage single-operator type. The working mechanism of all controls are contained in a ventilated inclosed cabinet, with hand regulators and switches mounted on a panel which forms a side of the cabinet.

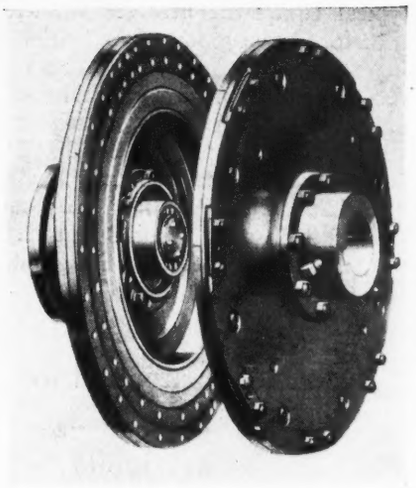
It is driven by a six-cylinder engine with an S.A.E. rating of 33.75 and a brake horsepower, at 1,500 r.p.m., of 55. The unit is equipped with an automatic throttle control which permits the engine to idle at about half speed when the arc is not going. When the arc is struck the engine immediately comes up to full speed. A time delay keeps the engine going at full speed when the arc is momentarily broken, and it will not slow down for a predetermined time interval after breaking the arc. This permits the operator to change electrodes, etc., without affecting the speed.



Engine driven welder with automatic throttle control

A New Line of Magnetic Clutches

BETTER and more consistent operating characteristics, easier installation, greater safety and easier access to parts are claimed for a new line of magnetic clutches, type L, announced by Cutler-Hammer, Inc., 190-12th St., Milwaukee, Wis.



Magnetic clutch with armature and field separated

The magnet coil of the improved clutch is locked in place by four mounting studs which extend through the field casting. Loosening the four studs allows removal of the entire coil. All coil terminals are recessed below the surface of the field member to protect them against damage.

A centering bearing, which is a roller bearing mounted in the field member and which protrudes so that it fits into a recess in the armature hub, forms a common support for both clutch members, yet allows either member to revolve independently of the other when disengaged. This construction assures perfect alignment and concentric engagement of the members.

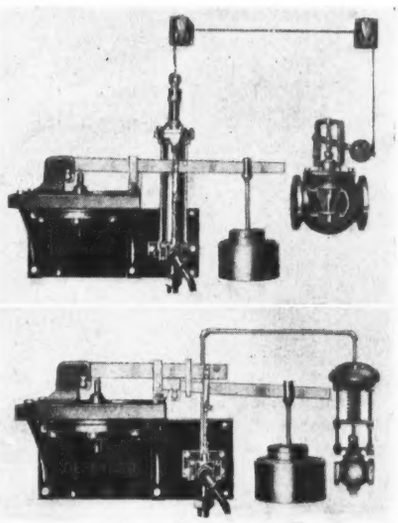
A definite improvement has been made in the design of the collector rings for these clutches. The rings are made of brass to prevent corrosion, and are mounted away from the hub, on four insulated studs, so it is practically impossible for sufficient dust to collect to cause creepage between the rings. Two carbon brushes are used on each ring. A lining-wear indicator shows the operator when the lining has worn to a point where it must be readjusted.

Pressure Regulator for Steam, Liquids and Air

THE accompanying illustration shows two types of pressure regulators put out by the Defender Automatic Regulator Company, St. Louis, Mo., for use with practically any type of lever or diaphragm-operated regulating valve on steam, air, gas, and oil lines. The regulator shown in the upper view is a single-lever unit equipped with an operating cylinder. It is designed for use with a lever-type balanced valve, as shown. Several valves may be controlled from one operating cylinder, or a number of cylinders may be used on a single control.

A double-lever unit for use on pressures from 40 to 250 lb. is shown in the lower view. This unit is fitted with a small pilot valve for controlling the pressure to the diaphragm chamber of the regulating valve. The complete control shown can be used as a reducing valve, pump or air compressor governor; or to control the flow of steam or liquid for practically any purpose.

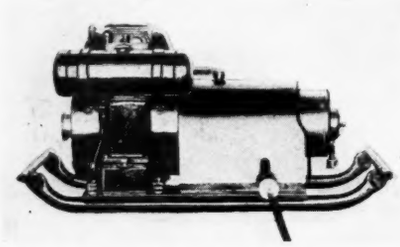
Both regulators are designed to operate on a fraction of a pound variation in pressure and to maintain the reduced pressure within close limits.



Pressure regulators for use with lever- and diaphragm-operated valves

Small Portable Power Unit

A PORTABLE power plant weighing only 120 lb. and capable of deliverying 1,000 watts is

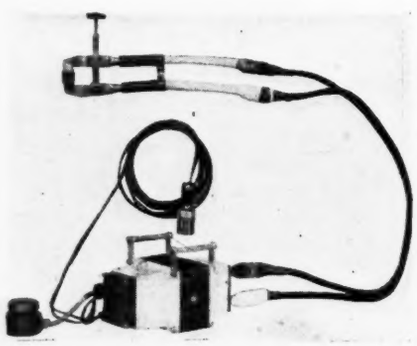


Portable power unit mounted on skids

illustrated. It is powered by a gasoline engine developing 2 hp. at 4,000 r.p.m. The engine speed is controlled by an automatic mechanical governor, accurate speed adjustment being provided between 1,800 and 4,000 r.p.m. There is only one exposed moving part. All other parts are inclosed in a sealed bath of oil. The gasoline tank has a capacity of 2½ quarts, sufficient to operate the engine for three hours under full load conditions. The unit, put out by Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., is provided with duralumin skids to facilitate transport.

Electric Brazing Equipment

ELECTRIC BRAZING equipment consisting of a transformer, foot switch and tongs is announced by the General Electric



Transformer with foot switch and tongs

Company Schenectady, N. Y. With this equipment brazing is done by heat generated by the flow of electricity through carbon blocks. A typical equipment involves a 5-kva. transformer weighing 45 lb. and having a 220-volt primary and an 8-volt secondary. A 10-kva. transformer unit for heavier duty having the same primary taps and 8-, 10 and 12-volt taps on the secondary is also available. The secondary taps can be readily changed for different sizes of joints, the higher taps being used for larger sections.

Expansive Compound for Sealing Thread, Flange and Gasket Joints

TO THE line of high-temperature cements and protective coatings manufactured by the Quigley Company, 56 West 45th St., New York City, has recently been added a plastic expansive compound for sealing joints known as Q-seal.

Among the claims made for the new compound, which is said to be a natural lubricant and preserver of metal, are that it withstands high pressures and temperatures, remains plastic, is unaffected by vibration and expands when subjected to heat. It is suitable for sealing screw threads, gaskets and metal-to-metal joints on lines carrying steam, air, acids, oils, etc. Joints made with the compound may be readily broken regardless of age. It can also be used as a paint to prevent rust and corrosion.

It is put up in 3-oz., 1-lb. and 5-lb. tins, 10-, 30-, and 60-lb. containers, and 350- and 500-lb. steel drums.

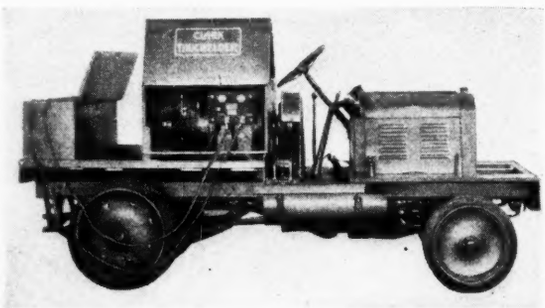
Portable Electric Arc-Welding Unit

A COMPLETE, mobile, self-contained gas-powered electric-arc welding unit, put out by the Clark-Tructractor Company, Battle Creek, Mich., is illustrated.

Arc welding current, ranging from 60 to 250 amp. at 25 volts, is developed by a self-excited arc-welding generator, with control, driven by a special heavy-duty, 4-cylinder gas engine developing 20 hp. at 1,480 r.p.m. Currents between 25 and 60 amp. may also be obtained by inserting in the circuit a current-reducing resistor provided for the purpose. The current available is ample for use with all commercial sizes of metallic electrodes from $\frac{1}{16}$ to $\frac{3}{16}$ in., also for light carbon welding and cutting.

Engine and generator are connected by a 3-in.-wide special composition belt. The generator is thrown in and released by a hand-controlled ball-bearing belt tightener.

Automatic stabilizing of the welding arc is provided by a self-adjusting arc-stabilizing reactor. For striking the arc a high open-circuit voltage of 65 volts is available, after which the voltage is automatically reduced to that required to maintain the arc. Adjustments in the range of welding current, from 60 to 250 amp., are made by simply shifting the generator brushes by means of an external handle. Further adjustment down to 25 amp. is made by a shift of electrode leads.



Complete welding plant mounted on motor truck

BOLT-DIE HEADS FOR RATCHET STOCK—Bolt-die heads are now available for the No. 3 Beaver ratchet die stock, manufactured by the Borden Company, Warren, Ohio, for threading bolts, rods, etc., in all sizes from $\frac{1}{8}$ to 1 in., inclusive.

EISEN-HEISS is the name given to an acid-proof paint put out by the Master Mechanics Company, Cleveland, Ohio. It is said to resist the action of acid fumes, brine, heat and condensation and suitable for use on boiler fronts, hot and cold pipes, tanks, etc.

NEWS of the FIELD

Spot News

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BY A VOTE *of eleven to five the San Francisco Board of Supervisors has approved a charter amendment creating a public utilities commission, consisting of three elected members holding office six years at salaries of $6,000 each. This amendment will be submitted to the voters at the Nov. 4 election.*

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ANNOUNCEMENT *is made that the 60,000-kw. James H. Reed steam-electric generating station of the Duquesne Light Company, on Brunot Island in Pittsburgh, Pa., will be completed and placed in trial operation on or about Oct. 1. The station will be officially opened and dedicated on Oct. 16.*

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THE LARGEST ORDER *for hollow-core copper cable in the history of the western states has just been placed by the Pacific Gas & Electric Company with the Anaconda Wire & Cable Company. The contract calls for 166 miles of 1-in. cable, which will be used in a transmission line from the company's new $40,000,000 hydro-electric development on the Mokelumne River to the Newark substation.*

Hoover to Start Fifteen Mile Falls Plant, Largest Hydro Completed This Year

PRESIDENT HOOVER will turn a golden key in the White House at 10:30 on the morning of Sept. 30, and instantly the largest hydro-electric plant completed in the United States this year will begin operation.

The energy supplied by the President's finger will travel over a special 700-mile circuit to the upper Connecticut River midway between St. Johnsbury, Vt., and Littleton, N. H., where the mammoth Fifteen Mile Falls lower development has just been completed by the New England Power Association, a subsidiary of International Paper & Power Company.

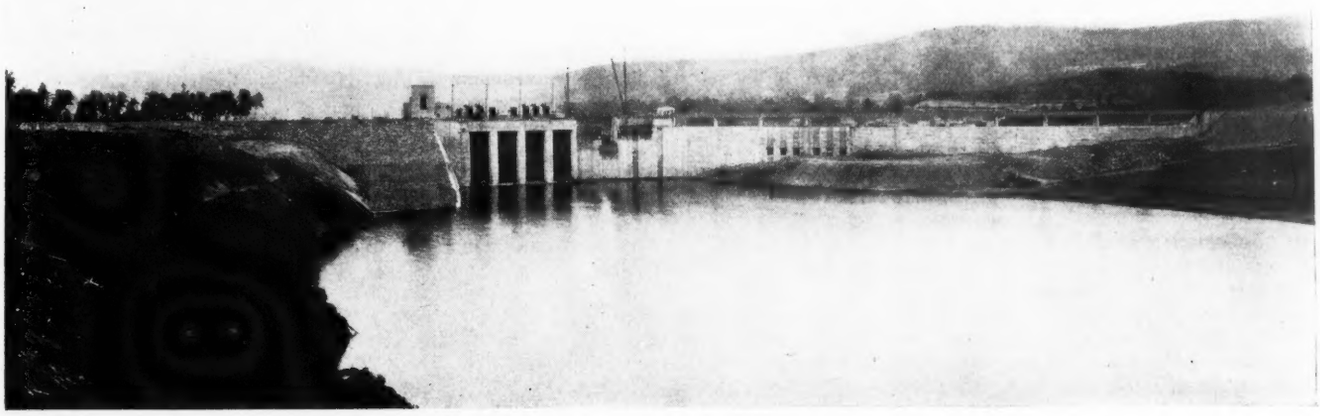
President Hoover's participation will be the most important feature of the dedicatory exercises of this largest unit of New England's largest electric utility system. Public officials from four states and 250 municipalities in which units of the company operate, will gather at Fifteen Mile Falls for the dedication.

The Fifteen Mile Falls development was one of the biggest construction jobs in New England's history. The main dam rises 175 ft. above the bed of the river. On the Vermont side is the spillway, 850 ft. long and varying in height from 20 to 85 ft. This leads to the main part of the dam, on top of which is one of the biggest transformer banks in that section of the country and the lofty towers from which wires pass to the outdoor switching station on the New Hampshire hillside.

At this station electrical energy which will be generated at 13,800 volts, will be stepped up to 66,000 volts for local distribution and to 220,000 volts for transmission over the 126-mile double-circuit steel tower line which runs to another new switching station at Tewksbury, Massachusetts. Recently completed, this is the longest high-voltage transmission line in New England. Beyond the intake section is an earth dam, anchored with the largest concrete retaining wall ever built in the United States. This wall extends 500 ft. upstream and 395 ft. downstream from the center of the dam, is 175 ft. high at its mid-section.

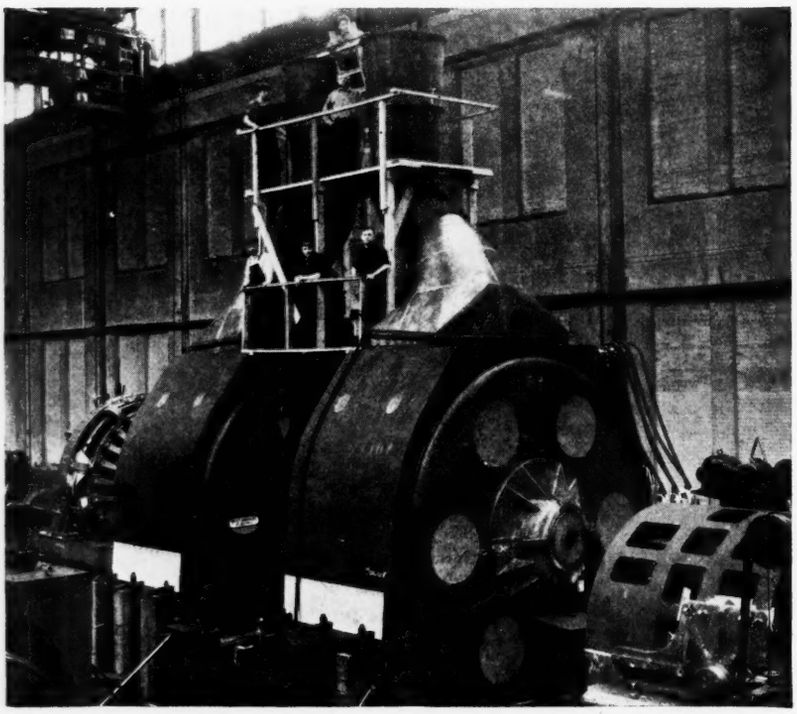
The power house is built in the river directly below the dam. The main building is 236 ft. long and 99 ft. wide. The generator room contains four vertical-type generators directly connected to the waterwheels. Each unit is capable of developing 54,000 hp.

On Oct. 1 the new plant will start supplying a large quantity of electric power to the Edison Electric Illuminating Company of Boston. This power will be sold under a contract providing for the delivery of electricity for renewable periods extending for twenty years. The contract covers the sale of 100,000,000 kw.-hr. of primary electricity during the year beginning Oct. 1, and (except during the last two years) of 150,000,000 kw.-hr. of electricity annually during the balance of the term.



Upstream side of Fifteen Mile Falls lower development, showing the beginning of water storage following dam closure

LARGEST SYNCHRONOUS MOTORS



What are believed to be the world's most powerful synchronous motors for marine or industrial service are shown here on test at the East Pittsburgh works of the Westinghouse Electric & Manufacturing Company. These two motors, each of which is rated at 13,250 shaft horsepower, will drive a 23,000 gross ton steamship of the Dollar Line

▼ ▼ ▼

Installing Diesel Engine in Chicago Office Building

The first installation of a large diesel engine in a Chicago office building is nearing completion in the 21-story Conway Building of the Marshall Field Estate. The new machine will supplement a three-unit steam plant. During the heating season it will serve as a standby unit, but in the summer, when the demand for exhaust steam does not exceed that required for hot water and boiler feed, the diesel unit will be operated at full capacity as the primary generating unit, and will be supplemented by one of the steam units as required. In this way advantage will be taken of the much higher operating efficiency of the diesel engine as compared to that of a steam unit operating non-condensing when there is little demand for the exhaust steam.

The electrical load and the size of the steam units are such that should anything happen to the large steam unit, the two smaller machines would carry the winter load temporarily but not continuously. With no outside breakdown service, the plant was in need of a reserve unit, so selection was made of a machine that would not only function in this capacity but would offer in addition the advantage of improving plant economy during the non-heating season. This new unit is to be a Cooper-Bessemer 450-hp., six-cylinder, vertical diesel, directly connected to a 300-kw., 220-volt, three-wire direct-current Crocker-Wheeler generator. Utilization of exhaust gases is being considered as a future possibility.

In an office building installation of this character, one of the problems encountered was the design of a foundation that would not transmit vibration or sound to the steel framework of the building. As a preliminary step, forms were built to construct in the foundation excavation, a carefully waterproofed monolithic concrete tank with a bottom 15 in. thick and 12-in. sides. It rests on clay soil, between the concrete building caissons which go down to solid rock. As two of these caissons cut in slightly into the form, they have been surrounded by sheet steel to form a slip joint between the concrete of the caisson and the concrete of the tank. The tank will be lined with cork, $3\frac{1}{2}$ in. thick on the bottom and $1\frac{1}{2}$ in. around the four sides. The engine block will be poured inside the cork. A combined weight of 50 tons for the unit and 80 tons for the foundation block will impose a load on the cork approximating 850 lb. per square foot. The outside shell in the foundation will have no contact with the floor, so that the unit and its supporting elements will be isolated completely from the building structure.

A.I.E.E. District Meeting in Philadelphia, Oct. 13-15

The sixth meeting of the Middle Eastern District of the American Institute of Electrical Engineers will be held in Philadelphia, Pa., from Oct. 13 to 15, with headquarters at the Benjamin Franklin Hotel. An interesting program of events is scheduled for the meeting, comprising five technical sessions, a conference of branch counselors and chairmen, an informal reception with dancing, a banquet followed by entertainment, a number of interesting inspection trips and outdoor sports.

Technical papers of unusual interest, some of which are associated with local engineering projects, are to be presented at the meeting. Papers scheduled for the hydro-electric power session on Monday afternoon, Oct. 13, include: "Hydraulic and Electrical Possibilities of High-Speed Low-Head Developments," by George A. Jessop and C. A. Powel; "Trend in Design and Capacity of Large Hydro-Electric Generators," by M. C. Olson; "Automatic Economy Control Applied to Hydraulic Plants," by S. Logan Kerr; "Damper Windings for Water-Wheel Generators."

At the electrical equipment session on Tuesday afternoon, the following papers will be read: "Air Conditioning in Industry," by A. H. Clogston; "Outdoor Switching Equipment at Northwest Station Commonwealth Edison Company," by W. F. Sims and C. G. Axell; "A New System of Speed Control—A.C. Motor-Driven Power Station Auxiliaries," by A. M. Rossman; "Transformers With Load-Ratio Control," by A. Palme; "Forces in Turbine-Generator Stator Windings," by J. F. Calvert. A. H. Candee will deliver a paper on "The Internal Combustion Engine as an Adjunct to Electrification" at the railway electrification session on Wednesday morning.

Visits to Deepwater Station, Conowingo hydro-electric plant, Philadelphia Electric Company substations, the American Brown-Boveri Company factory at Camden, N. J., and the Philadelphia plants of the General Electric Company and Westinghouse Electric & Manufacturing Company are included on the program of inspection trips.

Order New River Generators

The New Kanawha Power Company, subsidiary of the Union Carbide & Carbon Corporation, has awarded a contract to the Westinghouse Electric & Manufacturing Company, approximating $1,000,000. This contract calls for delivery and erection at customer's power house of four 30,000-kva., 3-phase, 6,900-volt, 25-cycle, 150 r.p.m., vertical water-wheel generators with direct connected and pilot exciters.

The generators will be installed on New River about two miles above the junction of Gauley River and New River. This location is approximately 40 miles above Charleston, W. Va.

West Penn Saves Navigation on Monongahela River

Complete cessation of navigation on a section of the Monongahela River with resultant closing down of many plants, unemployment of thousands and loss of millions was averted recently through cooperation with the West Penn Power Company, it was revealed recently by Col. Jarvis J. Bain, United States Engineer for the Pittsburgh district, who stated that the navigation pools have been kept as near normal as possible by virtue of periodic releases of water from Lake Lynn, the power company's huge reservoir on the Cheat River, W. Va.

When the seriousness of the situation due to the prolonged drought was called to the attention of the West Penn officials, Colonel Bain was assured, he stated, that the company would do everything in its power to alleviate conditions on the river and accordingly plans were laid to discharge water out of the Cheat Reservoir which would provide a heavy flow into the middle section of the Monongahela for use of the several locks which were threatened with a shutdown.

The West Penn officials informed Colonel Bain that further release of the Lake Lynn storage would leave them unprepared for emergency demand for power and a conference with Duquesne Light Company officials followed with the result the latter company agreed to stand by in case of emergency, furnishing the West Penn company whatever energy it might need. Thus, Colonel Bain stated, the West Penn was free to release millions of gallons of water and save the situation for the numerous plants that line the Monongahela and upper Ohio rivers.

Ford Gets "Jumbo" Dynamo From New York Edison

Henry Ford has obtained from the New York Edison Company for his Museum of American Industries the only remaining dynamo that was part of the original equipment designed and built by Thomas A. Edison for the world's first central station of the electric light and power industry, the old Pearl Street station, New York City. Mr. Edison installed six dynamos in this first station, which began operation Sept. 4, 1882. About two years later two more machines were installed, on account of growth of business. Seven were lost in a fire that partly destroyed the original station Jan. 2, 1890.

These dynamos, much larger than any known up to the time of their manufacture, were called Jumbos. The one saved was known as Jumbo No. 6. It has been in the possession of the New York Edison Company, and on Tuesday, Sept. 9, Ford company trucks carried it to the Ford assembly plant in Long Island City, where it will be crated for shipment to the museum. Accompanying the dynamo is the Armington & Sims Steam engine that furnished power to operate the machine. According to a letter from Mr. Ford's office. "It is Mr. Ford's idea to build a part of Pearl Street station in which to install the relic." The unit, consisting of engine and dynamo, weighs about 30 tons.

At the time they were built, the Jumbos were rated at 1,200 16-candlepower lamps, and later were run up to 1,750 16-candlepower lamps. Each Jumbo had a generating capacity of approximately 125 hp. Today single machines have a capacity exceeding 200,000 horsepower.

Baron Shiba Honored at Engineers' Luncheon

Eighty-five prominent engineers, representing the Founder Societies, assembled at a testimonial luncheon in honor of Baron Chuzaburo Shiba of Japan at the Engineers Club, New York on Sept. 23. The Baron, who it will be recalled was vice-chairman and the moving spirit of the World Engineering Conference at Tokyo last fall, is on his way back to Japan after having represented that country at the recent World Power Conference in Berlin.

George Otis Smith, director of the United States Geological Survey, who was a member of the party of American engineers that attended the Tokyo meeting, was the principal speaker at the luncheon and paid a graceful tribute to Baron Shiba and to the engineers of Japan. He stressed the human side of engineering and pointed out that the greatest value of such contacts as those established at Tokyo lie in the discovery of likeness rather than differences in viewpoint.

John R. Freeman referred to the engineering research that is going on in Japan and to the leadership her engineers have established in the design of earthquake-proof structures. A telegram of greetings was also read from President Hoover.

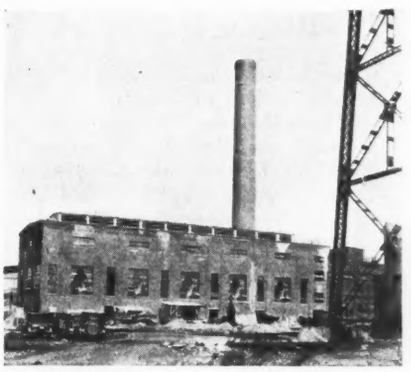
Construction Started on Rock Island-Everett Line

Actual construction of the proposed $1,300,000 power transmission line from the new Rock Island plant of the Puget Sound Power & Light Company to Beverly Park substation, Everett, Wash., is now in progress. T. H. Campbell, engineer of the company, is in direct charge of the work. The plans call for a first transmission line from the 80,000-hp. unit of the plant to be ready in 1932, to be built to Wenatchee, where it will connect with the White River-Wenatchee transmission line. An outdoor switch station will be installed at the junction.

News of Canada

Gatineau boiler plant nearing completion—Second Paugan-Toronto line placed in operation—Jordan River addition progressing rapidly

CONSTRUCTION WORK is rapidly being finished on the new boiler plant for the newsprint paper mill of the Canadian International Paper Company at Gatineau, Que. The boiler house will be completed and ready for operation during the early part of October, when electric energy now being delivered by the Gatineau Power Company for the generation of steam



Gatineau boiler house nears completion

at the mill will be released for delivery to the Hydro-Electric Power Commission of Ontario under its contracts with the power company.

Built at a cost of approximately $1,000,000, the new plant will house five boilers, four of which are now being installed, with the fifth to be added later when the load increases sufficiently to warrant it. The four boilers comprising the initial installation are Kidwell units with an aggregate heating surface of 52,000 sq.ft. They will be fired by pulverized coal and equipped with the latest control devices.

A recent construction view of the plant is shown in the accompanying illustration.

THE SECOND 230-mile transmission line from the Paugan, Que., hydro-electric plant of Gatineau Power Company to Toronto has been placed in commercial service. The new line is a 220,000-volt steel tower aluminum line, a duplicate of the first one, and is being used in conjunction with it for the delivery of power under contract to the Hydro-Electric Power Commission of Ontario.

The two lines are approximately 100 ft. apart and have the distinction of being the highest-voltage transmission lines in operation in Canada. Over these lines the company is at present delivering to the commission 150,000 hp. of electric energy, which is being distributed in the Toronto area to sup-

plement the power supplied from Niagara Falls. The route which the two lines follow was surveyed by aërial photography, resulting in lower cost and the saving of much valuable time.

DEVELOPMENT of an additional 18,000 hp. at the Jordan River power plant of the British Columbia Electric Railway Company will be completed on Nov. 15, according to engineers of the power plant. The new 18,000-hp. water turbine together with the rotor of the generator which is keyed to the centre of a massive shaft and the stator have now been landed at the power plant and the assembling of the machinery is under way.

New Appropriation for Hoover Dam Work

Unofficial but reliable information has been obtained to the effect that an item of $25,000,000 has been approved in the budget for carrying on the work at Hoover Dam, in Boulder Canyon, Colo. Whatever money is appropriated for the work will be provided in the Interior Department appropriation bill.

The appropriations endorsed in the budget will not become available until the beginning of the next fiscal year June 30, 1931. It is thought in some quarters that to expedite the work, Congress may take it upon itself to increase the appropriation by another $25,000,000.

Reports have drifted into Washington that it has been decided to rename the construction town that is being built in Nevada. It was first propsed to call this town Summit. According to the reports it has now been agreed to name it after the Secretary of the Interior, Ray Lyman Wilbur. Hence the little desert town will now be called Wilbur.

In explanation of the dignity giving the town by naming it after a celebrity, it is stated that some large chemical companies have decided to select it as the location for their plants because of the fact that large amount of power soon will be available. While it was at first thought that the town would be only a temporary construction camp, it now appears that it will be a permanent settlement.

Los Angeles Board Reduces Power Bond Issue

Following the action of the Board of Water and Power Commissioners of Los Angeles, Calif., in unanimously adopting a resolution requesting the City Council to place a $13,300,000 power bond issue on the Nov. 4 ballot, E. F. Scattergood, chief electrical engineer and general manager of the Bureau of Power and Light, made the following statement:

"Provision for financing certain of the items heretofore included in the previously proposed $19,000,000 power bond issue are to be temporarily deferred. The principal items to be eliminated from the power bond issue as originally outlined, are those providing for the construction of a transmission line from Owens Valley and of the power plants on Big Pine Creek which it was the intention of the department to build at this time." (See *Power* for Aug. 26, page 368.)

The power construction program as adopted by the Board of Water and Power Commissioners, provides for the expenditure over the three year period ending 1933, of $25,500,000. Of this sum $12,000,000 will be provided from the surplus revenues of the Bureau of Power and Light, the remaining $13,300,000 being provided from the bonds to be voted on Nov. 4.

COMING CONVENTIONS

American Society of Mechanical Engineers. Fall meeting at French Lick Springs, Ind., Oct. 13-17. National Wood Industries Division. Meeting at the Hotel Pennsylvania, New York City, Oct. 16-17. National Petroleum Meeting at Tulsa, Okla., Oct. 6-8. Annual meeting in New York City, Dec. 1-5. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Engineering Council. Administrative board meeting at the Mayflower Hotel, Washington, D. C., Oct. 17-18. Secretary, L. W. Wallace, 26 Jackson Pl., Washington, D. C.

American Institute of Electrical Engineers. District meeting at Philadelphia, Pa., Oct. 13-15. District meeting at Louisville, Ky., Nov. 19-22. Annual Winter convention in New York City, Jan. 26-30, 1931. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Refrigerating Engineers. Annual meeting at the Hotel New Yorker, New York City, Dec. 3-6. Secretary, David L. Fiske, 37 West 39th St., New York City.

Midwest Power Engineering Conference and Exposition. Fifth meeting in Chicago, Ill., Feb. 10-13, 1931. Secretary, George E. Pfisterer, 308 West Washington St., Chicago, Ill.

National Association of Practical Refrigerating Engineers. Annual convention and exhibition at the Hotel Peabody, Memphis, Tenn., Nov. 11-14. Secretary, Edward H. Fox, 5707 West Lake St., Chicago, Ill.

National Power Show. Grand Central Palace, New York City, Dec. 1-6. Manager, Charles F. Roth, Grand Central Palace, New York City.

Society of Industrial Engineers. Seventeenth national convention at the Mayflower Hotel, Washington, D. C., Oct. 15-17. Secretary, George C. Dent, 205 West Wacker Drive, Chicago, Ill.

Stoker Manufacturers Association. Fall meeting at the Homestead, Hot Springs, Va., Nov. 3-5. Secretary, William V. McAllister, Foot of Walker St., Detroit, Mich.

Personals

LIEUT.-GEN. EDGAR JADWIN has been made chairman of a board of engineers to assist the St. Lawrence Power Development Commission of New York in determining the technical feasibility and financial cost of the proposed St. Lawrence River hydro-electric project. Other members of the board are: WILLIAM H. WOODWARD, consulting engineer of New York City; O. G. THURLOW, hydro-electric engineer of Birmingham, Ala.; COL. FREDERICK STUART GREENE, superintendent of the State Department of Public Works at Albany.

R. H. PARK, for the past six years with the General Electric Company in various engineering capacities, has recently joined the Stone & Webster Engineering Corporation at its Boston office as engineer in the electrical division.

ARTHUR C. DAWE, of Ashley, Pa.; DAN ROGERS, of Baltimore, Md.; and JOHN LYNCH of Erie, Pa., were recently appointed boiler inspectors for the Department of Labor and Industry of Pennsylvania.

JAMES C. DE LONG has retired from presidency of the Syracuse Lighting Company, Syracuse, N. Y., to become chairman of its board of directors. A veteran among public utility leaders, Mr. De Long this year completes 51 years in public utility work, 23 of which were spent as an officer of the Syracuse company. At present he is recovering from injuries sustained in an automobile accident, at Rome, N. Y., on Sept. 13.

MORRIS STONE, mechanical engineer of the Westinghouse Electric & Manufacturing Company, has just been granted the second award of the Benjamin Garver Lamme scholarship. The award provides one year's advanced study at any college or university in America or abroad.

R. A. SHARON, for the past three years assistant to the vice-president and general manager of the Great Western Power Company of California, with headquarters in San Francisco, has resigned from the Pacific Gas & Electric Company, which recently took over the Great Western Company, to become affiliated with the Electric Bond & Share Company, New York City. He will take up his new duties on Oct. 1.

G. ROSS HENNINGER, for the past six years engineering editor of *Electrical West*, with headquarters in San Francisco, has resigned to become associate editor of the *Journal* of the American Institute of Electrical Engineers. He will leave for New York City on Oct. 1 to take up his new work. Mr. Henninger went to McGraw-Hill Company of California from the Southern California Edison Company where he was serving as operating assistant.

Business Notes

SARCO COMPANY, New York City, announces the appointment of the following sales representatives: F. W. Scheer, Pearl and Court Sts., Buffalo, N. Y.; Williamson & Woody, 1138 Mutual Bldg., Richmond, Va.; Engineering Equipment Company, 209 Glenn Bldg., Atlanta, Ga.; Stewart Roberts, 215 West 7th St., Chattanooga, Tenn. Coincidentally with these appointments, the Erie section of Pennsylvania has been turned over to the Cleveland office, 805 Bulkley Bldg., which is in charge of F. K. Minor.

A. D. COOK, INC., Lawrenceburg, Ind., has opened a Michigan office in Grand Rapids. James R. Hamilton is the sales representative in charge, and H. B. Allen Sickel, formerly vice-president and chief engineer of the Layne-Ohio Company, is the consulting engineer and superintendent of gravel-packed well installations.

STAYNEW FILTER CORPORATION, Rochester, N. Y., has moved its factory and main office to larger quarters at 25 Leighton Ave., Rochester, to take care of increasing business.

A. M. BYERS COMPANY, Pittsburgh, Pa., announces the transfer of H. R. Howland, division manager at Philadelphia, to Pittsburgh as division manager. E. L. MacWhorter, who has been representing the company in western New York, has been made Philadelphia division manager to succeed Mr. Howland. Announcement is also made of a national sales meeting to be held in Pittsburgh early in October, in conjunction with the official opening of the company's new $12,000,000 plant.

THE FOXBORO COMPANY, Foxboro, Mass., announces the appointment of C. C. Fuller as manager of the New York office to replace the late W. W. Patrick. He will be assisted by K. L. Barton, R. A. Rockwell and F. J. Leerburger.

GENERAL CABLE CORPORATION, Rome, N. Y., announces that effective Oct. 1, the sales, manufacturing and accounting operations of the following companies, which have operated as separate divisions, will be combined into a single organization under the corporation itself: A-A Wire Company, American Insulated Wire & Cable Company, Atlantic Insulated Wire & Cable Company, Detroit Insulated Wire Company, Dudlo Manufacturing Company, Peerless Insulated Wire & Cable Company, Phillips Wire Company, Rome Electrical Company, Rome Wire Company, Safety Cable Company, Standard Underground Cable Company and Southern States Cable Company.

LEAVITT MACHINE COMPANY, Orange, Mass., announces the appointment of Pierce F. Chartres, 80 South Allen St., Albany, N. Y., as its representative in the eastern New York territory.

How's Business?

INDUSTRIAL production, except in steel, is still bumping along the August bottom, showing somewhat less than seasonal improvement, and primary distribution continues a bit backward. Building projects, especially residential, are doing better than was expected at this season, and general trade has shown more than seasonal expansion in September.

Our preliminary index of business activity for the week ended Sept. 20 has risen further from 84% of normal to 85.6%. The rate of improvement, however, is still too slow to warrant expectation of return to normal levels in the few remaining months of this year, without more vigorous Federal Reserve action and business leadership, of which there is still no sign. We have probably missed the train again this Fall, as we did last Spring. — *The Business Week*, Oct. 1.

Trade Catalogs

STOKERS—Catalog, "The Whiting Stoker." Whiting Corporation, Harvey, Ill.

BOILERS—Bulletin, "Union 'L' Type Boilers," James T. Castle, 424 First Ave., Pittsburgh, Pa.

REFRACTORIES—"Kingdo" refractory patch; "Flame Brand" high-temperature refractories; "Mono" boiler baffling; King Refractories Company, 1709-1715 Niagara St., Buffalo, N. Y.

PIPING — Catalogs, "Standard Pipe Reference Book" and "Youngstown Pipe," Youngstown Sheet & Tube Company, Youngstown, Ohio.

FILTERS — Bulletin 120, air filters; American Air Filter Company, First and Central Ave., Louisville, Ky.

MOTORS AND GENERATORS — Bulletin J-2, direct-current generator and motor; J-3, engine-type alternating current generators; L-5, synchronous motors; Elliott Company, Jeannette, Pa.

CLEANERS—Bulletin Z-8, tube cleaners, Liberty Manufacturing Company, Jeannette, Pa.

BOILERS—Catalog, "Collins Western Water-Tube Boilers," Collins Western Corporation, 517 Hollingsworth Bldg., Los Angeles, Calif.

SPEED REDUCERS — Bulletin 230, parallel shaft speed reducers, The Falk Corporation, Milwaukee, Wis.

HEATERS — Catalog No. 129, unit heaters and copper radiation, Wolverine Tube Company, 1411 Central Ave., Detroit, Mich.

CLEANER—Booklet, "Cleaning Compound," Quigley Company, 56 West 45th St., New York City.

RESEARCH — Booklet, "Research for Industry," Battelle Memorial Institute, Columbus, Ohio.

CLEANER — Bulletin 158, compressed air cleaner, Centrifix Corporation, 5029 Prospect Ave., Cleveland, Ohio.

NOZZLES—Bulletin No. 475, nozzles, Spraco, Inc., 114 Central St., Somerville, Mass.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Navy Standard	New York	$2.10 @$2.30
Kanawha	Cincinnati	1.10 @ 1.35
Smokeless	Cincinnati	1.85 @ 2.00
Smokeless	Chicago	2.00 @ 2.25
West Kentucky	Louisville	.85 @ 1.25
Steam	Pittsburgh	1.50 @ 1.60
Gas Slack	Pittsburgh	.90 @ 1.10
Big Seam	Birmingham	1.60 @ 1.75

Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.00
Barley	New York	1.25 @ 1.50

FUEL OIL

New York—Sept. 25, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c.@5.25c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c.@6.25c. per gal.

St. Louis—Sept. 18, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.345 per bbl., or 42 gal.; 26@28 deg., $1.445 per bbl.; 28@30 deg., $1.545 per bbl.; 30@32 deg., $1.652 per bbl.; 32@36 deg., gas oil, 4.026c. per gal.; 38@40 deg., distillate, 4.526c. per gal.

Pittsburgh — Sept. 17, f.o.b. local refinery, 34@36 deg., fuel oil, 3.5c. per gal.; 36@40 deg., 3.5c.

Philadelphia—Sept. 16, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati — Sept. 16, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Sept. 10, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 60c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., 87.5c. per bbl.

Boston—Sept. 22, tank-car lots, f.o.b., 12@14 deg., Baumé, 3.3c. per gal.; 28@32 deg., 5c. per gal.

Dallas—Sept. 13, f.o.b. local refinery 26@30 deg., $1.10 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Benton—Arkansas State Hospital for Nervous Diseases, c/o State Construction Commission, J. M. Hill, Fort Smith, Chn., is having plans prepared for a group of buildings including dormitories, kitchen, store, central power and heating plants, etc., here. Mann, Wanger & King, Donaghey Bldg., Little Rock and S. W. Jones & Associates, 25 West 45th St., New York, are architects. Lund Engineering Co., Home Insurance Bldg., Little Rock, are engineers.

Calif., Agnew — Dept. of Public Works, Sacramento, is having plans prepared for a group of farm colony buildings including power house, etc. at State Hospital, here. Estimated cost $352,000. G. B. McDougall, c/o Dept. of Public Works, is state architect.

Calif., Brawley—City plans an election soon to vote $180,000 bonds for waterworks filtration plant, including filter units, low lift pumping equipment, etc. Burns-McDonnell-Smith Engineering Co., Western Pacific Bldg., Los Angeles, are engineers.

Calif., Los Angeles — Sunset Loma Holding Co., Sunset Blvd. and Alto Loma Dr., will build a 13 story apartment building including steam heating system, two electric elevators, etc. Estimated cost $1,225,000. A. I. Ronda, 502 Lissner Bldg., is architect. Work will be done by day labor.

Calif., San Francisco—Bd. of Regents, University of California, Berkeley, will receive bids until Oct. 17, for the installation of electric, air and steam lines on Campus, here.

Conn., New Britain—Southern New England Ice Co., R. G. Hadley, Pres., is having plans prepared for an ice manufacturing plant on Corbin Pl. Estimated cost $100,000. Private plans.

Conn., New Haven — St. Raphael Hospital, 1442 Chapel St., awarded contract for the construction of a 1 story, 68 x 80 ft. boiler house and laundry to E. McKeown, 937 Dixwell Ave. Estimated cost $40,000.

Ill., Colchester—City plans an election soon to vote $70,000 bonds for waterworks improvements including well, pump house, two centrifugal pumps, etc. W. A. Fuller Co., 2916 Shenandoah Ave., St. Louis, Mo., are engineers.

Ind., Greenwood—Gulf Pipe Line Co., Frick Annex, Pittsburgh, Pa., had plans prepared for the construction of a power plant and pumping station including equipment, here. Estimated cost $250,000. Private plans.

Kan., Leoti—City, C. H. Simon, Clk., will receive bids until Oct. 3, for a complete waterworks system (excepting well and pumps) to include pump house, tank on tower, etc. C. A. Haskins, 822 Finance Bldg., Kansas City, is engineer.

Ky., Louisville—Louisville Gas & Electric Co., L. S. Streng, V. Pres., 311 West Chestnut St., has work under way on a high tension power line, 82 mi. long from Louisville to Cincinnati, O., 40,000 kw. capacity, 132,000 v. Will transmit power generated by hydro-electric plant at Louisville to Cincinnati. Estimated cost $1,000,000. Work being done by owner's forces. Three 18,750 kw. transformers to be installed at Louisville plant.

Mass., Billerica—Boston & Maine R.R. Co., Boston, awarded contract for a waterworks system including pump house, etc., here, to Pitman & Brown Co., 11 Washington St., Salem, Mass. Estimated cost to exceed $15,000. W. J. Backes, Boston, is chief engineer.

Mass., Boston—Institutions Dept., will soon award contract for alterations and repairs to refrigeration plant at Long Island Hospital. Private plans.

Mass., Springfield—United Electric Light Co., State St., awarded contract for the construction of a coal handling plant and equipment to Adams & Ruxton, 1387 Main St.

Mass., Weymouth—Weymouth Light & Power Co., 1371 Commercial St., is receiving bids for the construction of a power sub-station at South Weymouth. Estimated cost $40,000. E. J. Batty, 13 Temple St., Quincy, is engineer.

Mich., Battle Creek—State, c/o G. R. Thompson, State Budget Dir., will soon award contract for a 100,000 gal. reservoir, three pumping stations, etc., for Roosevelt American Legion Hospital. E. D. Rich, Michigan Dept. of Health, Lansing, is engineer.

Mich., Wyandotte—City is having plans prepared for the construction of a power house for generating electric power on Van Alstyne Blvd. Estimated cost $300,000. Froelich & Emery, Second National Bank Bldg., Toledo, O., are engineers.

N. J., Jersey City — Bd. of Commissioners, City Hall, will receive new bids until Oct. 7, for addition to power house, laundry and tunnel at Baldwin and Montgomery Sts. Estimated cost $800,000. J. T. Rowland, Jr., 30 Journal Sq., is engineer.

N. J., Jersey City — Mongiello Bros., 625 Communipaw Ave., will receive bids about Oct. 15 for the construction of an ice plant. Estimated cost $50,000. C. H. Ziegler, 26 Journal Sq., is engineer.

N. Y., Newark — Dept. of Mental Hygiene, Capitol, Albany, will soon award contract for construction and heating work for service connections (tunnels) and additional boiler capacity at Newark State School here.

N. J., Trenton — Dept. of Institutions & Agencies, will soon award contract for the construction of a power house at State Prison. Estimated cost $75,000. C. N. Leathem, Jr., State Bldg., is engineer.

O., East Canton—City is having preliminary surveys made for waterworks ssytem to include drilling of wells, pumping station, etc. Estimated cost $75,000. G. Davidson, Canton, is engineer.

Okla., Mangum—City plans an election Oct. 14, for a waterworks system including wells and pumping equipment, etc. Estimated cost $108,000. H. T. Lawrence, Mangum, is engineer.

Pa., Tarentum — City, L. R. Conroy, Secy., Boro Hall, will soon award contract for addition to electric light plant on 5th St. Estimated cost $150,000. M. Knowles, Westinghouse Bldg., Pittsburgh, is engineer.

Wash., Olympia—Port Commission, is having plans prepared for the construction of first unit of cold storage plant, 5,000 bbl. capacity. Estimated cost $100,000. Total estimated cost $500,000. O. Murray and J. J. Wohleb, are engineers.

Equipment Wanted

Engines—Sikeston, Mo.—City, N. E. Fuchs, Mayor and P. H. Stevenson, Clk., will receive bids about Oct. 15, for two large Diesel engines, etc. for proposed municipal power plant. Estimated cost $150,000.

Generating Units, Pumps, etc.—Morgan City, La.—City cancelled bids until further notice for two 400 kva. oil engine generating units complete with accessories; two 350 g.p.m. domestic service motor driven pumps; one 1,000 and one 3,000 g.p.m. low head motor driven pumps; 1,000 g.p.m. Underwriter motor driven pump; switchboard, etc. for proposed waterworks and electric power plant.

Pump—Ventnor, N. J.—Common Council, will receive bids until Oct. 13 for electrical pumps, etc., for proposed waterworks.

Pumping Equipment — Marrero, La. — East Jefferson Waterworks Dist., will receive bids until Oct. 30 for furnishing and installing pumping equipment for waterworks.

Pumps—Lamar, Mo.—City will receive bids until Oct. 7, for two 170 g.p.m. vertical centrifugal pumps direct connected to motor, one 250 and one 500 g.p.m. horizontal pumps direct connected to motors, etc., for proposed waterworks system.

Pumps — Taylor Township, Mich. — County Drain Commission, 1601 Barlum Tower, Detroit, will receive bids until Oct. 9 for two electrically driven pumps for proposed sewage treatment plant.

Pumps, etc.—Edinburg, Tex.—Hidalgo County Water Improvement Dist. 6, will receive bids until Oct. 15, for three pumps, etc., for proposed irrigation project. Estimated cost $300,000.

Pumps and Motors—Merced, Calif.—Merced Irrigation Dist., H. P. Sargent, Secy., will receive bids until Oct. 7, for three drainage pumps and motors complete.

Refrigerators, Compressors, etc. — Freehold, N. J.—Bd. of Chosen Freeholders, Court House, will receive bids until Oct. 8 for furnishing and installing two large refrigerators, compressors, ice making machinery, electric refrigerator, sterilizing equipment, etc., for County Welfare House.

Industrial Projects

Calif., Bakersfield — San Joaquin Light & Power Corp., Power Bldg., Fresno, awarded contract for a 1 story, 35 x 80 ft. meter shop here to C. Gramlin, Bakersfield.

Calif., Long Beach—Procter & Gamble, 300 Avery St., Los Angeles, awarded contract for a group of buildings for soap manufacturing plant here, to Clinton Construction Co., Spring-Arcade Bldg., Los Angeles. $750,000.

Calif., San Francisco—H. Moffatt & Co., 3rd and Arthur Ave., awarded contract for the construction of a 2 story cold storage plant to Barrett & Hilp, 918 Harrison St. Estimated cost $75,000.

Calif., Wilmington—Pacific Fiber & Cordage Co., 2740 Pacific St., San Pedro, had plans prepared for a 1 story, 60 x 150 ft. factory here. Estimated cost $100,000. Private plans.

Ind., Evansville — Mead Johnson Terminal Corp., St. Joseph Ave. Bank Bldg., awarded contract for a loading and unloading terminal, to M. J. Hoffman Construction Co., Central Union Bank Bldg. Estimated cost $150,000. Also 190 x 370 ft. warehouse to be constructed later. Total cost $400,000.

Ind., Fort Wayne — Fries Tool & Machine Co., 1918 East Wayne St., will receive bids about Nov. 1 for addition to factory. Estimated cost $40,000. G. Mahurin, 425 Standard Bldg., is architect.

Mass., Boston — R. C. A. Victor Co., 76 Atherton St., manufacturers of radios, awarded contract for the construction of a 2 story factory to Turner Construction Co., 178 Tremont St. Estimated cost $50,000.

Mich., Detroit — Great Lakes Steel Corp., Tecumseh Rd., subsidiary of National Steel Corp., 1319 Kingsbury St., Chicago, Ill., plans the construction of a 10 in. merchant mill here.

Minn., Duluth—Minnesota Power & Light Co., 30 West Superior St., awarded contract for an 8 story building, including office quarters to be used in connection with gas distribution plant. Estimated cost $2,000,000 for first unit.

Mo., St. Louis—St. Louis Screw & Bolt Co., E. J. Miller, Pres., 6900 North Broadway, will soon receive bids for a 1 story, 180 x 240 ft. addition to manufacturing plant, including 40 ton open hearth furnace and auxiliary equipment. Estimated cost $250,000.

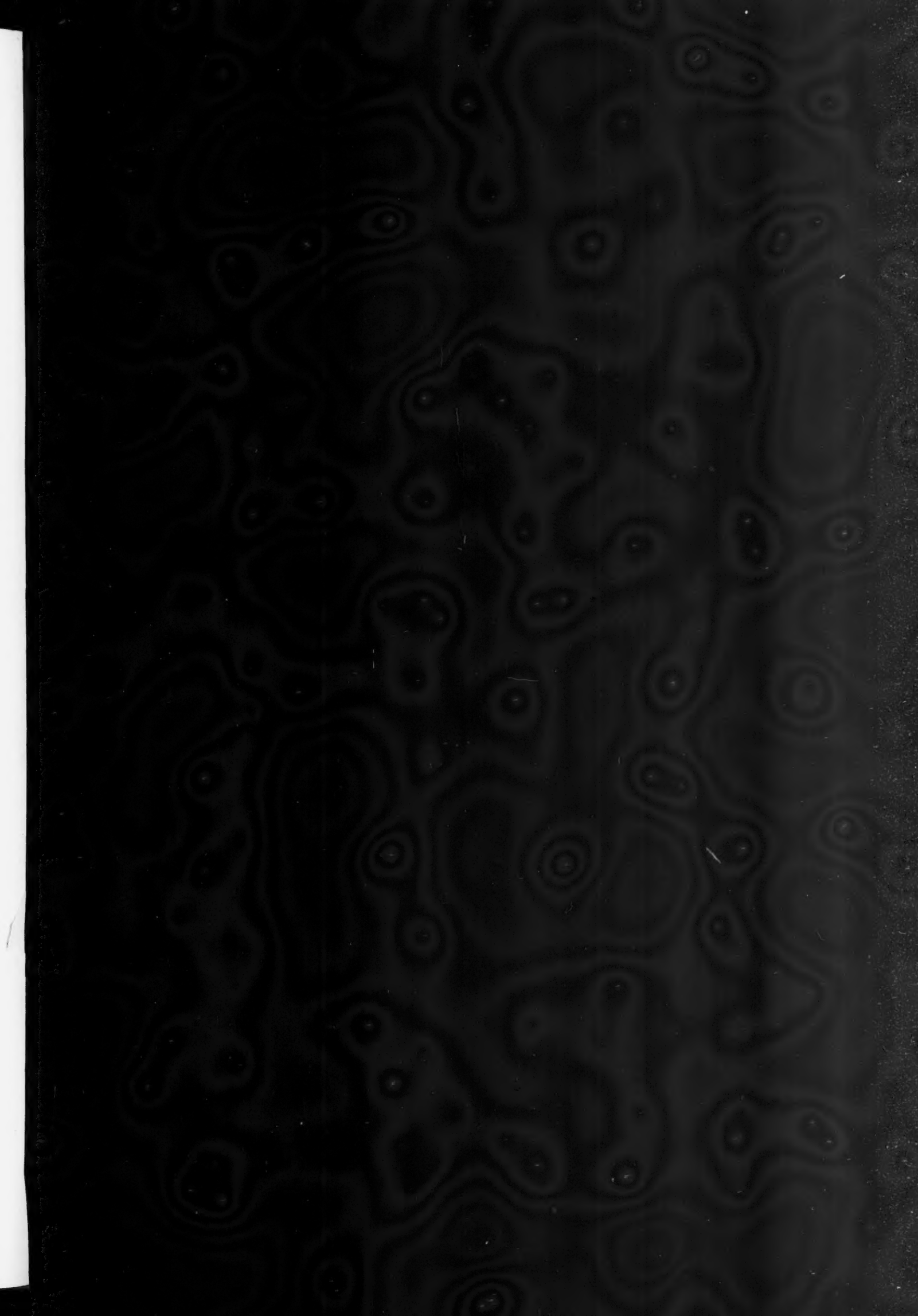
N. J., New Brunswick—Anheuser-Busch Co., 721 Pestlozi St., St. Louis, Mo., plans the construction of a plant here for the manufacture of cartons. Estimated cost $1,000,000.

O., Cleveland — Cleveland Wire Works, Incandescent Lamp Dept. of General Electric Co., c/o E. G. Edwards, Mgr., Nela Park, is having plans prepared for a 1 story, 320 x 370 ft. factory, power plant and boiler house on Chardon Rd. Estimated cost $750,000. Private plans.

O., Cleveland—Cleveland Steel Products Co., 7300 Madison Ave., manufacturers of oil burners, awarded contract for the construction of a 1 story, 78 x 80 ft. factory, to H. E. Kleffman Co., 2844 Lorain Ave. Estimated cost $40,000.

O., Cleveland—Otis Steel Co., C. C. Wales, Const. Engr., 3341 Jennings Rd., had plans prepared for the construction of a 1 story continuous mill building. Estimated cost $400,000. Private plans.

Tex., San Antonio — Southwest Ceramic Products Co., Independence, Mo., plans the construction of a plant for the manufacture of Fayence tile principally used for walls and floors, here. Estimated cost $250,000. Machinery and equipment will be required.

Ont., Brockville—E. F. Phillips Electric Co. Ltd., 12 Mercer St., Toronto, will soon award contract for addition to electric wire plant, including new electrical shop, machine shop, boiler house, rubber room, braiding room, finishing shop, etc., here. Estimated cost $500,000. J. M. Miller, 648 Dorchester St., Montreal, Que., is architect.

Ont., Kirkland Lake — Wright-Hargreaves Mines Ltd., plans additions to gold mining plant including improvements to main head frame, complete new electric crusher unit and increasing air compressor capacity. Estimated cost $150,000. Private plans.